FD671D/FD711D
FD750D
FD791D (DFI)

4–stroke liquid-cooled v-twin gasoline engine

Service Manual

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LIST OF ABBREVIATIONS

A	ampere(s)	lb	pound(s)
ABDC	after bottom dead center	m	meter(s)
AC	alternating current	min	minute(s)
ATDC	after top dead center	N	newton(s)
BBDC	before bottom dead center	Pa	pascal(s)
BDC	bottom dead center	PS	horsepower
BTDC	before top dead center	psi	pound(s) per square inch
°C	degree(s) Celsius	r	revolution
DC	direct current	rpm	revolution(s) per minute
F	farad(s)	TDC	top dead center
°F	degree(s) Fahrenheit	TIR	total indicator reading
ft	foot, feet	V	volt(s)
g	gram(s)	W	watt(s)
h	hour(s)	Ω	ohm(s)
L	liter(s)		

Read OWNER'S MANUAL before operating.

EMISSION CONTROL INFORMATION

To protect the environment in which we live, Kawasaki has incorporated crankcase emission (1) and exhaust emission (2) control systems in compliance with applicable regulations of the United States Environmental Protection Agency and the California Air Resources Board.

1. **Crankcase Emission Control System**
   A sealed-type crankcase emission control system is used to eliminate blow-by gasses. The blow-by gasses are led to a breather chamber through the crankcase and from there to the air cleaner.
   Oil is separated from the gasses while passing through the inside of the breather chamber from the crankcase, and then returned to the bottom of the crankcase.
2. **Exhaust Emission Control System**
   The exhaust emission control system applied to this engine consists of a carburetor and an ignition system having optimum ignition timing characteristics.
   The carburetor has been calibrated to provide lean air/fuel mixture characteristics and optimum fuel economy with a suitable air cleaner and exhaust system.

TAMPERING WITH EMISSION CONTROL SYSTEM PROHIBITED

Federal law and California State law prohibits the following acts or the causing thereof: (1) the removal or rendering inoperative by any person other than for purposes of maintenance, repair, or replacement, of any device or element of design incorporated into any new engine for the purpose of emission control prior to its sale or delivery to the ultimate purchaser or while it is in use, or (2) the use of the engine after such device or element of design has been removed or rendered inoperative by any person.

Among those acts presumed to constitute tampering are the acts listed below:
Do not tamper with the original emission related part.

- Carburetor and internal parts
- Spark plugs
- Magneto or electronic ignition system
- Fuel filter element
- Air cleaner elements
- Crankcase
- Cylinder heads
- Breather chamber and internal parts
- Intake pipe and tube

Foreword

This manual is designed primarily for use by trained mechanics in a properly equipped shop. However, it contains enough detail and basic information to make it useful to the owner who desires to perform his own basic maintenance and repair work. A basic knowledge of mechanics, the proper use of tools, and workshop procedures must be understood in order to carry out maintenance and repair satisfactorily. Whenever the owner has insufficient experience or doubts as to his ability to do the work, all adjustments, maintenance, and repair should be carried out only by qualified mechanics.

In order to perform the work efficiently and to avoid costly mistakes, read the text, thoroughly familiarize yourself with the procedures before starting work, and then do the work carefully in a clean area. Whenever special tools or equipment are specified, do not use makeshift tools or equipment. Precision measurements can only be made if the proper instruments are used, and the use of substitute tools may adversely affect safe operation.

To get the longest life out of your engine:

- Follow the Periodic Maintenance Chart in the Service Manual.
- Be alert for problems and non-scheduled maintenance.
- Use proper tools and genuine Kawasaki engine parts. Genuine parts provided as spare parts are listed in the Parts Catalog.
- Follow the procedures in this manual carefully. Don't take shortcuts.
- Remember to keep complete records of maintenance and repair with dates and any new parts installed.

How to Use This Manual

In preparing this manual, we divided the product into its major systems. These systems became the manual's chapters. All information for a particular system from adjustment through disassembly and inspection is located in a single chapter.

The Quick Reference Guide shows you all of the product's system and assists in locating their chapters. Each chapter in turn has its own comprehensive Table of Contents.

The Periodic Maintenance Chart is located in the General Information chapter. The chart gives a time schedule for required maintenance operations.

If you want spark plug information, for example, go to the Periodic Maintenance Chart first. The chart tells you how frequently to clean and gap the plug. Next, use the Quick Reference Guide to locate the Electrical System chapter. Then, use the Table of Contents on the first page of the chapter to find the Spark Plug section.

Whenever you see these WARNING and CAUTION symbols, heed their instructions! Always follow safe operating and maintenance practices.

⚠WARNING

This warning symbol identifies special instructions or procedures which, if not correctly followed, could result in personal injury, or loss of life.

CAUTION

This caution symbol identifies special instructions or procedures which, if not strictly observed, could result in damage to or destruction of equipment.

This manual contains four more symbols (in addition to WARNING and CAUTION) which will help you distinguish different types of information.

NOTE

○ *This note symbol indicates points of particular interest for more efficient and convenient operation.*

- ● Indicates a procedural step or work to be done.
- ○ Indicates a procedural sub-step or how to do the work of the procedural step it follows. It also precedes the text of a WARNING, CAUTION, or NOTE.
- ★ Indicates a conditional step or what action to take based on the results of the test or inspection in the procedural step or sub-step it follows.

In most chapters an exploded view illustration of the system components follows the Table of Contents. In these illustrations you will find the instructions indicating which parts require specified tightening torque, oil, grease or a locking agent during assembly.

General Information

Table of Contents

Before Servicing....1-2
Model Identification....1-4
General Specifications....1-5
Periodic Maintenance Chart....1-7
Torque and Locking Agent....1-8
Special Tools....1-9

1-2 GENERAL INFORMATION

Before Servicing

Before starting to service the engine, carefully read the applicable section to eliminate unnecessary work. Photographs, diagrams, notes, cautions, warnings, and detailed descriptions have been included wherever necessary. Nevertheless, even a detailed account has limitations, a certain amount of basic knowledge is required for successful work.

Especially note the following:

(1) Dirt

Before removal and disassembly, clean the engine. Any dirt entering the engine, carburetor, or other parts, will work as an abrasive and shorten the life of engine. For the same reason, before installing a new part, clean off any dust or metal filings.

(2) Battery Ground

Remove the ground (—) lead from the battery before performing any disassembly operations on the equipment. This prevents:

(a) the possibility of accidentally turning the engine over while partially disassembled.

(b) sparks at electrical connections which will occur when they are disconnected.

(c) damage to electrical parts.

(3) Tightening Sequence

Generally, when installing a part with several bolts, nuts, or screws, start them all in their holes and tighten them to a snug fit. Then tighten them evenly, in a staggered sequence. This is to avoid distortion of the part and/or causing gas or oil leakage. Conversely, when loosening the bolts, nuts, or screws, first loosen all of them by about a quarter of a turn and then remove them. Where there is a tightening sequence indication in this Service Manual, the bolts, nuts, or screws must be tightened in the order and method indicated.

(4) Torque

When torque values are given in this Service Manual, use them. Either too little or too much torque may lead to serious damage. Use a good quality, reliable torque wrench.

(5) Force

Common sense should dictate how much force is necessary in assembly and disassembly. If a part seems especially difficult to remove or install, stop and examine what may be causing the problem. Whenever tapping is necessary, tap lightly using a wooden or plastic-faced mallet. Use an impact driver for screws (particularly for the removal of screws held by a locking agent) in order to avoid damaging the heads.

(6) Edges

Watch for sharp edges, especially during major engine disassembly and assembly. Protect your hands with gloves or a piece of thick cloth when lifting the engine or turning it over.

(7) High-Flash Point Solvent

A high-flash point solvent is recommended to reduce fire danger. A commercial solvent commonly available in North America is Standard solvent (generic name). Always follow manufacturer and container directions regarding the use of any solvent.

(8) Gasket, O-Ring

Do not reuse a gasket or O-ring once it has been in service. The mating surfaces around the gasket should be free of foreign matter and perfectly smooth to avoid oil or compression leaks.

(9) Liquid Gasket, Non-Permanent Locking Agent

Follow manufacturer's directions for cleaning and preparing surfaces where these compounds will be used. Apply sparingly. Excessive amounts may block engine oil passages and cause serious damage. An example of a non-permanent locking agent commonly available in North America is Loctite Lock'n Seal (Blue).

(10) Press

A part installed using a press or driver, such as a journal, should first be coated with oil on its outer or inner circumference so that it will go into place smoothly.

(11) Ball Bearing

When installing a ball bearing, the bearing race which is affected by friction should be pushed by a suitable driver. This prevents severe stress on the balls and races, and prevents races and balls from being dented. Press a ball bearing until it stops at the stop in the hole or on the shaft.

(12) Oil Seal and Grease Seal

Replace any oil or grease seals that were removed with new ones, as removal generally damages seals.

When pressing in a seal which has manufacturer's marks, press it in with the marks facing out. Seals should be pressed into place using a suitable driver, which contacts evenly with the side of seal, until the face of the seal is even with the end of the hole.

(13) Seal Guide

A seal guide is required for certain oil or grease seals during installation to avoid damage to the seal lips. Before a shaft passes through a seal, apply a little oil, preferably high temperature grease on the lips to reduce rubber to metal friction.

(14) Circlip, Retaining Ring

Replace any circlips and retaining rings that were removed with new ones, as removal weakens and deforms them. When installing circlips and retaining rings, take care to compress or expand them only enough to install them and no more.

Before Servicing

(15) Cotter Pin

Replace any cotter pins that were removed with new ones, as removal deforms and breaks them.

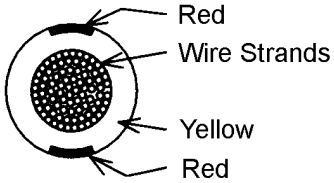
(16) Lubrication

Engine wear is generally at its maximum while the engine is warming up and before all the rubbing surfaces have an adequate lubricative film. During assembly, oil or grease (whichever is more suitable) should be applied to any rubbing surface which has lost its lubricative film. Old grease and dirty oil should be cleaned off. Deteriorated grease has lost its lubricative quality and may contain abrasive foreign particles.

Don't use just any oil or grease. Some oils and greases in particular should be used only in certain applications and may be harmful if used in an application for which they are not intended. This manual makes reference to molybdenum disulfide grease (MoS_2) in the assembly of certain engine parts. Always check manufacturer recommendations before using such special lubricants.

(17) Electrical Wires

All the electrical wires are either single-color or two-color and, with only a few exceptions, must be connected to wires of the same color. On any of the two-color wires there is a greater amount of one color and a lesser amount of a second color, so a two-color wire is identified by first the primary color and then the secondary color. For example, a yellow wire with thin red stripes is referred to as a "yellow/red" wire; it would be a "red/yellow" wire if the colors were reversed to make red the main color.

Wire (cross-section)	Name of Wire Color
	Yellow/Red

(18) Replacement Parts

When there is a replacement instruction, replace these parts with new ones every time they are removed. There replacement parts will be damaged or lose their original function once removed.

(19) Inspection

When parts have been disassembled, visually inspect these parts for the following conditions or other damage. If there is any doubt as to the condition of them, replace them with new ones.

Abrasion	Crack	Hardening	Warp
Bent	Dent	Scratch	Wear
Color change	Deterioration	Seizure	

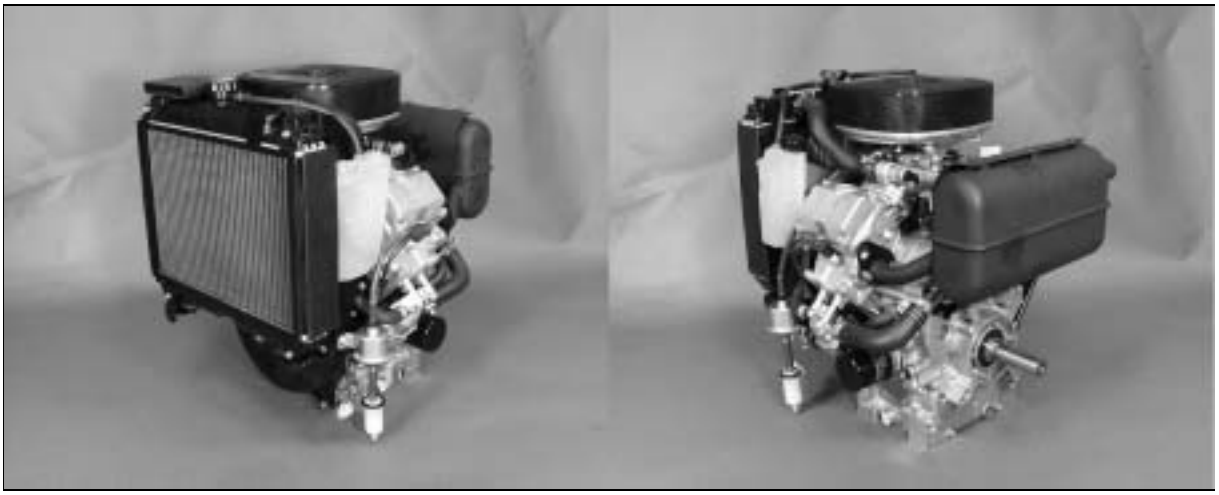
(20) Specifications

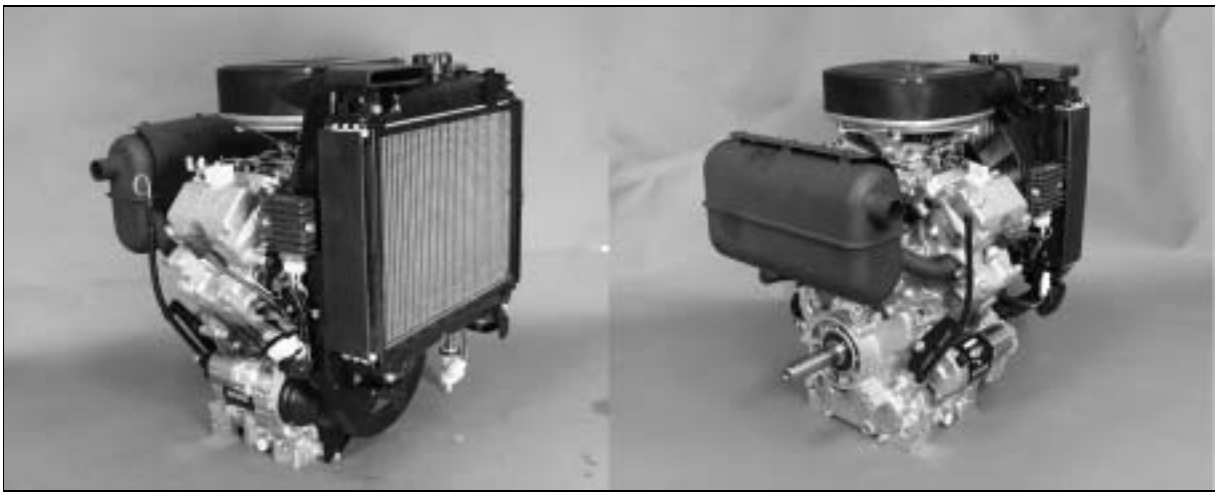
Specification terms are defined as follows:

"Standards" show dimensions or performances which brand-new parts or systems have.

"Service Limits" indicate the usable limits. If the measurement shows excessive wear or deteriorated performance, replace the damaged parts.

Model Identification





Cylinder Number Designation:

No.1 Cyl. is on the oil filter side.
No.2 Cyl. is on the electric starter side.

General Specifications

Items	FD671D, FD711D, FD750D
Type of engine	Liquid-cooled, Horizontal shaft, OHV, 4-stroke, 90°V-twin, Gasoline engine.
Bore x Stroke	2-78 mm x 78 mm (3.07 in x 3.07 in)
Piston displacement	745 mL (45.5 cu. in)
Direction of rotation	Counterclockwise facing the PTO shaft end
Low idle speed	1550 rpm
High idle speed	3600 rpm
Ignition system	Transistorized-fly wheel magneto
RFI	Per Canada and U.S.A. requirements
Starting system	Shift type electric starter
Charging system	12 V - 20 amps with regulator
Carburetor	Float type, fixed main jet
Fuel pump	Electro magnetic pump (in-line type)
Air cleaner	Dual stage element, dry type
Governor	All speed mechanical fly weights
Lubrication system	Pressure feed by positive displacement pump
Oil filter	Cartridge type full flow filter
Oil pressuer switch	ON-OFF switch
Oil capacity	2.0 L (2.1 US qt) [When oil filter is removed]
Cooling system	Pressurized forced circulation type
Radiator	2-rows with louverless corrugated fin (aluminum)
Dimensions (H x W x L)	520 mm x 458 mm x 580 mm
	(20.5 in x 17.9 in x 22.8 in)
Dry weight	58 kg (128 lb)

NOTE: Specifications are subject to change without notice.

1-6 GENERAL INFORMATION

General Specifications

Items	FD791D (DFI)
Type of engine	Liquid-cooled, Horizontal shaft, OHV, 4-stroke, 90°V-twin, Gasoline engine.
Bore x Stroke	2-78 mm x 78 mm (3.07 in x 3.07 in)
Piston displacement	745 mL (45.5 cu. in)
Direction of rotation	Counterclockwise facing the PTO shaft end
Low idle speed	1550 rpm
High idle speed	3600 rpm
Ignition system	Transistorized-fly wheel magneto
RFI	Per Canada and U.S.A. requirements
Starting system	Shift type electric starter
Charging system	12 V - 20 amps with regulator
Fuel System	DFI (Digital Fuel Injection)
Fuel pump	Electro magnetic pump (in-line type)
Air cleaner	Dual stage element, dry type
Governor	All speed mechanical fly weights
Lubrication system	Pressure feed by positive displacement pump
Oil filter	Cartridge type full flow filter
Oil pressuer switch	ON-OFF switch
Oil capacity	2.0 L (2.1 US qt) [When oil filter is removed]
Cooling system	Pressurized forced circulation type
Radiator	2-rows with louverless corrugated fin (aluminum)
Dimensions (H x W x L)	520 mm x 458 mm x 580 mm
	(20.5 in x 17.5 in x 22.8 in)
Dry weight	59 kg (130 lb)

NOTE: Specifications are subject to change without notice.

Periodic Maintenance Chart

To ensure satisfactory operation over an extended period of time, any engine requires normal maintenance regular intervals. The Periodic Maintenance Chart below shows periodic inspection and maintenance items and suitable intervals. The bullet mark (•) designates that the corresponding item should be performed at that interval.

Some adjustments require the use of special tools or other equipment. An electronic tachometer will facilitate setting idle and running speeds.

⚠WARNING

Always remove the spark plug cap from spark plug when servicing the engine to prevent accidental starting.

MAINTENANCE	INTERVAL							
	Daily	First 8 hr.	Every 25 hr.	Every 50 hr.	Every 100 hr.	Every 200 hr.	Every 300 hr.	Every 400 hr.
Check and add engine oil, coolant and fuel	●							
Check for loose or lost nuts and screws	●							
Check for fuel, oil and coolant leakage	●							
Check battery electrolyte level	●							
Check or clean air intake screen	●							
Tighten nuts and screws			●					
★ Clean air cleaner foam element			●					
★ Clean air cleaner paper element					●			
Change engine oil		●			●			
Clean and regap spark plug					●			
Replace oil filter						●		
★ Replace air cleaner paper element							●	
K Clean conbustion chamber							●	
K Check and adjust valve clearance							●	
K Clean and lap valve seating surface							●	
K Inspect radiator and hoses						●		
K Check fan belt conditions and tension						●		
K Change coolant								●

NOTE: The service intervals indicated are to be used as a guide. Service should be performed more frequently as necessary by operating condition.

★: Service more frequently under dusty conditions.

K: Have an authorized Kawasaki engine dealer perform those services.

Torque and Locking Agent

The following tables lists the tightening torque for the major fasteners, and the parts requiring use of a non-permanent locking agent or liquid gasket.

Letters used in the "Remarks" column mean:

L : Apply a non-permanent locking agent to the threads.
M : Apply a molybdenum disulfide lubricant (grease or oil) to the threads, seated surface, or washer.
O : Apply an oil to the threads, seated surface, or washer.
S : Tighten the fasteners following the specified sequence.

Fastener	Torque			Remarks
	N·m	kg·m	ft·lb	
Fuel System:				
Air Cleaner Wing Nut	3	0.3	26 in·lb	
Carburetor, Intake Pipe Mounting Bolts	12	1.2	106 in·lb	
Governor Arm Nut	8	0.8	69 in·lb	
Fuel Shut-Off Solenoid Valve	7	0.7	61 in·lb	
Water Temperature Sensor	20	2.0	14	
Cooling System:				
Radiator Hoses Clamps Bolts (M6)	1.2	0.12	11 in·lb	
Radiator Mounting Bolts (M6)	6	0.6	52 in·lb	
Cooling Fan Shaft Nut	20	2.0	15	
Water Pump Cover Bolts	20	2.0	15	S
Thermo Switch	27	2.8	20	L
Engine Top End:				
Cylinder Head Bolts	27	2.8	20	S
Rocker Arm Bracket Mounting Bolts	22	2.2	16	
Valve Clearance Adjusting Locknuts	11	1.1	96 in·lb	
Spark Plugs	25	2.5	18	
Lubrication System:				
Oil Drain Plug	25	2.5	18	
Oil Pressure Switch	15	1.5	11	L
Camshaft/Crankshaft:				
Case Cover to Block Bolts	22	2.2	16	S
Con-Rod Big End Cap Bolts	21	2.1	15	O
Electrical System:				
Flywheel Bolt	56	5.7	41	
Starter Motor Mounting Bolts	20	2.0	15	

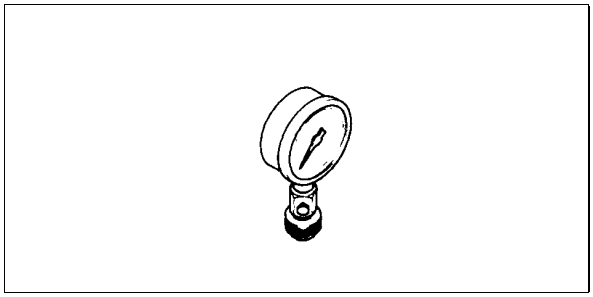
The table below, relating tightening torque to thread diameter, lists the basic torque for the bolts and nuts. Use this table for only the bolts and nuts which do not require a specific torque value. All of the values are for use with dry solvent-cleaned threads.

Basic Torque for General Fasteners

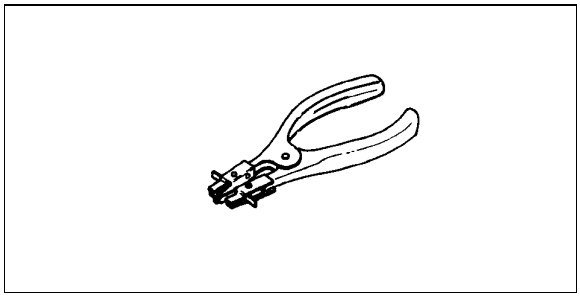
Threads dia	Torque		
(mm)	N·m	kg·m	ft·lb
5	3.4	0.35	30 in·lb
6	5.9	0.6	52 in·lb
8	15	1.5	11
10	20	2.0	15

Special Tools

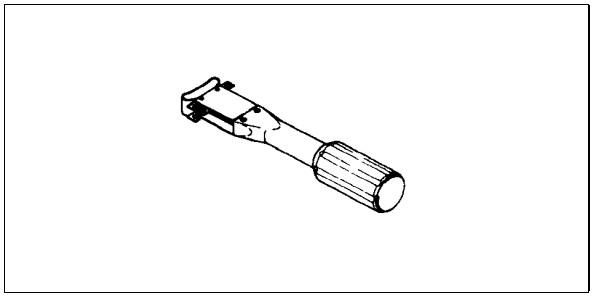
Compression Gauge: 57001–221



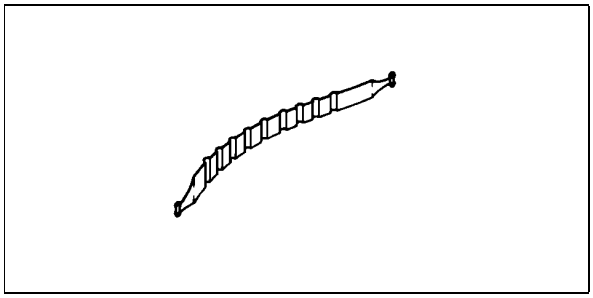
Piston Ring Pliers: 57001–115



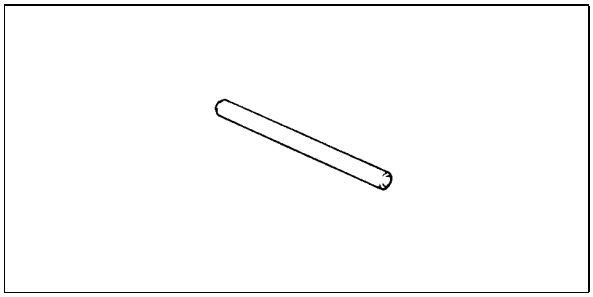
Piston Ring Compression Grip: 57001–1095



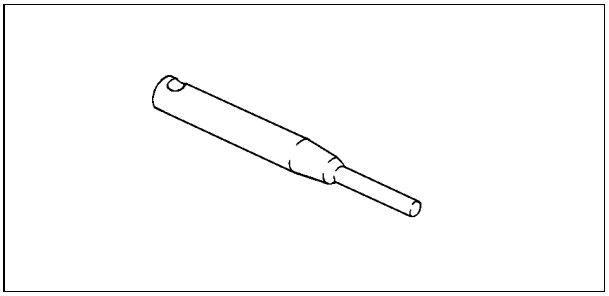
Piston Ring Compression Belt, Ø67 -Ø79: 57001–1097



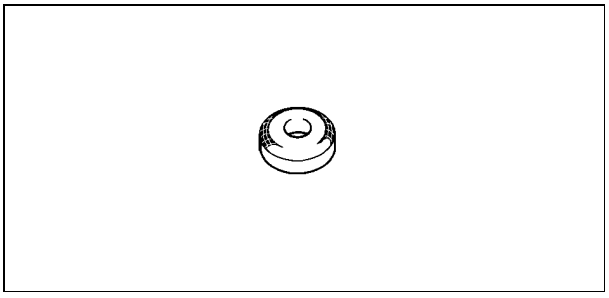
Valve Seat Cutter Holder Bar: 57001–1128



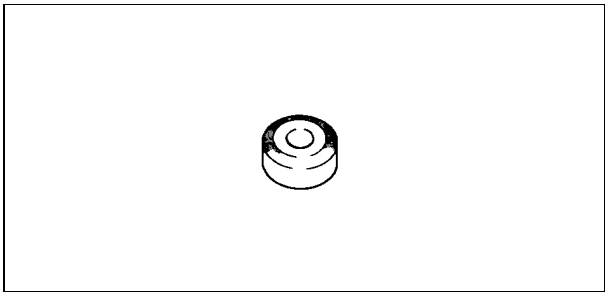
Valve Seat Cutter Holder, ϕ7 : 57001–1126



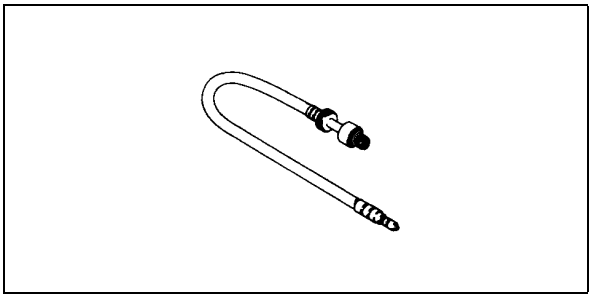
Valve Seat Cutter, 45° – ϕ35.0 : 57001–1116



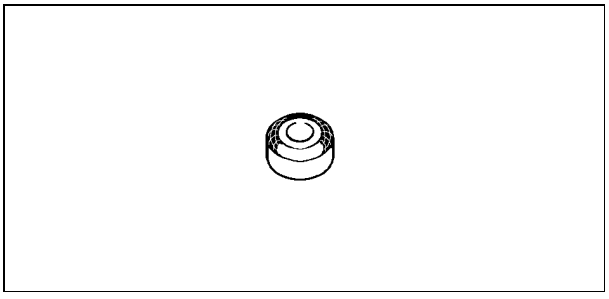
Valve Seat Cutter, 32° – ϕ33.0 : 57001–1199



Compression Gauge Adapter M14 x 1.25: 57001–1159

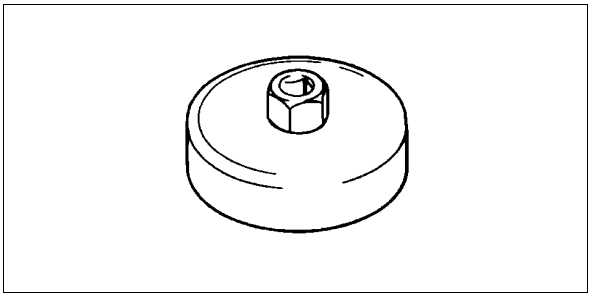


Valve Seat Cutter, 32° – ϕ30 : 57001–1120

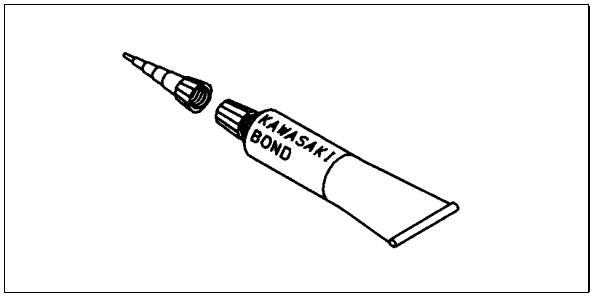


Special Tools

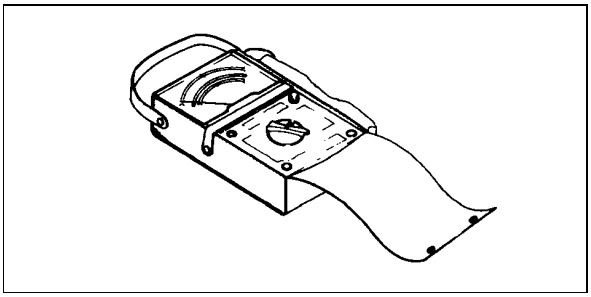
Oil Filter Wrench : 57001–1249



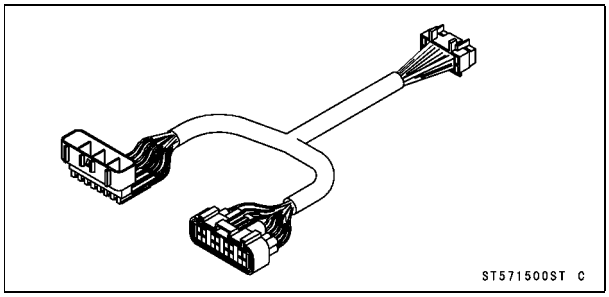
Kawasaki Bond (Silicone Sealant) : 56019–120



Hand Tester: 57001–1394



Read Wire ECU Adapter: 57001–1500



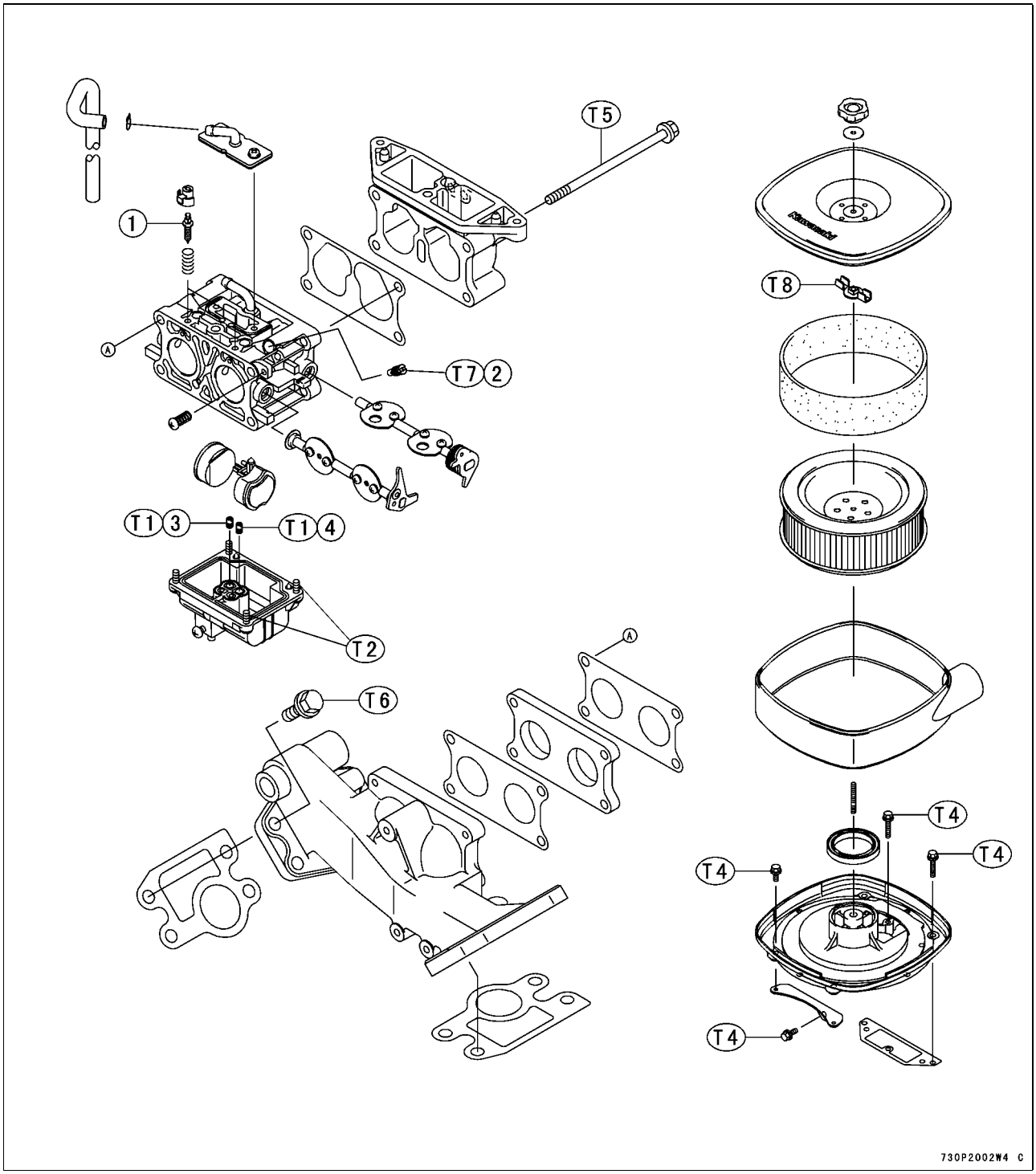
Fuel System

Table of Contents

Exploded View....2-3
Specifications....2-6
Governor Link Mechanism....2-8
Control Panel Assembly Removal....2-8
Control Panel Assembly Installation....2-8
Governor Arm Removal....2-8
Governor Arm Installation....2-9
Governor Assembly Removal....2-9
Governor Assembly Installation....2-9
Governor Assembly Inspection....2-9
Governor Shaft Removal....2-10
Governor Shaft Installation....2-10
Carburetor....2-11
Fuel and Air Flow....2-11
Fuel Shut Off Solenoid Valve....2-11
Low Idle Speed Adjustment....2-12
High Idle Speed Adjustment....2-12
High Altitude Operation....2-13
Main Jet Replacement....2-13
Fuel System Cleanliness Inspection....2-13
Carburetor Removal....2-13
Carburetor Installation....2-14
Carburetor Disassembly/Assembly....2-15
Carburetor Cleaning....2-16
Carburetor Inspection....2-16
Fuel Shut-Off Solenoid Valve Test....2-17
Intake Manifold....2-18
Intake Manifold Removal....2-18
Intake Manifold Installation....2-18
Intake Manifold Inspection....2-18
Fuel Pump....2-19
Fuel Pump Test....2-19
Air Cleaner....2-20
Element Removal....2-20
Element Installation....2-20
Element Cleaning and Inspection....2-20
Cleaner Body Removal....2-21
Cleaner Body Installation....2-21
Housing (Case and Body) Inspection....2-21
Digital Fuel Injection (DFI) System....2-22
Governor Link Mechanism....2-22
Control Panel Assembly Removal....2-22
Control Panel Assembly Installation....2-22
Governor Arm Removal....2-22
Governor Arm Installation....2-23
Throttle body Assy....2-23
Throttle Body Assy Removal....2-23
Throttle Body Assy Installation....2-23
Throttle Body Assy Disassembly....2-24
Throttle Body Assy Assembly....2-24
Low Idle Speed Adjustment....2-24
High Idle Speed Adjustment....2-25
Intake Manifold (DFI)....2-25
Intake Manifold (DFI) Removal....2-25
Intake Manifold (DFI) Installation....2-26
DFI System....2-27
DFI System Wiring Diagram....2-28
Terminal Numbers of ECU Connectors....2-29
Safety Instruction for DFI System Servicing....2-29
Electrical System....2-29
Fuel System....2-29
Air System....2-29
Electrical Control Unit (ECU)....2-30
ECU Removal....2-30
ECU Connector Inspection....2-30
ECU Ground Inspection....2-30
ECU Power Source Inspection....2-31
Fuel Pump....2-31
Fuel Pump Operation Inspection....2-31
Operating Voltage Inspection....2-31
Fuel Flow Rate Inspection....2-32
Fuel Injectors (#1, #2)....2-33
Fuel Injector Removal....2-33
Fuel Injector Installation....2-33
Power Source Voltage Inspection....2-33
Output Voltage Inspection....2-33
Audible Inspection....2-34
Injector Signal Test....2-34
Injector Resistance Inspection....2-35
Injector Unit Test....2-35
Fuel Pressure Regulator....2-35
Fuel pressure Regulator Removal....2-35
Fuel Pressure Regulator Installation....2-35
Fuel Pressure Regulator Inspection....2-36
Self-Diagnosis....2-36
Self-Diagnosis Outline....2-36
Self-Diagnosis Procedures....2-36
How to Read Fault Codes....2-37
Inlet Air Temperature Sensor (Fault Code 12)....2-37
Removal....2-37
Installation....2-38
Output Voltage Inspection....2-38

Sensor Resistance inspection.....2-39
Water Temperature Sensor (Fault Code 13).....2-39
Removal/Installation.....2-39
Output Voltage Inspection.....2-39
Water Temperature Sensor Inspection.....2-40
Vacuum Sensor (Fault Code 21).....2-40
Removal/Installation.....2-40
Input Voltage Inspection.....2-40
Output Voltage Inspection.....2-41

Exploded View



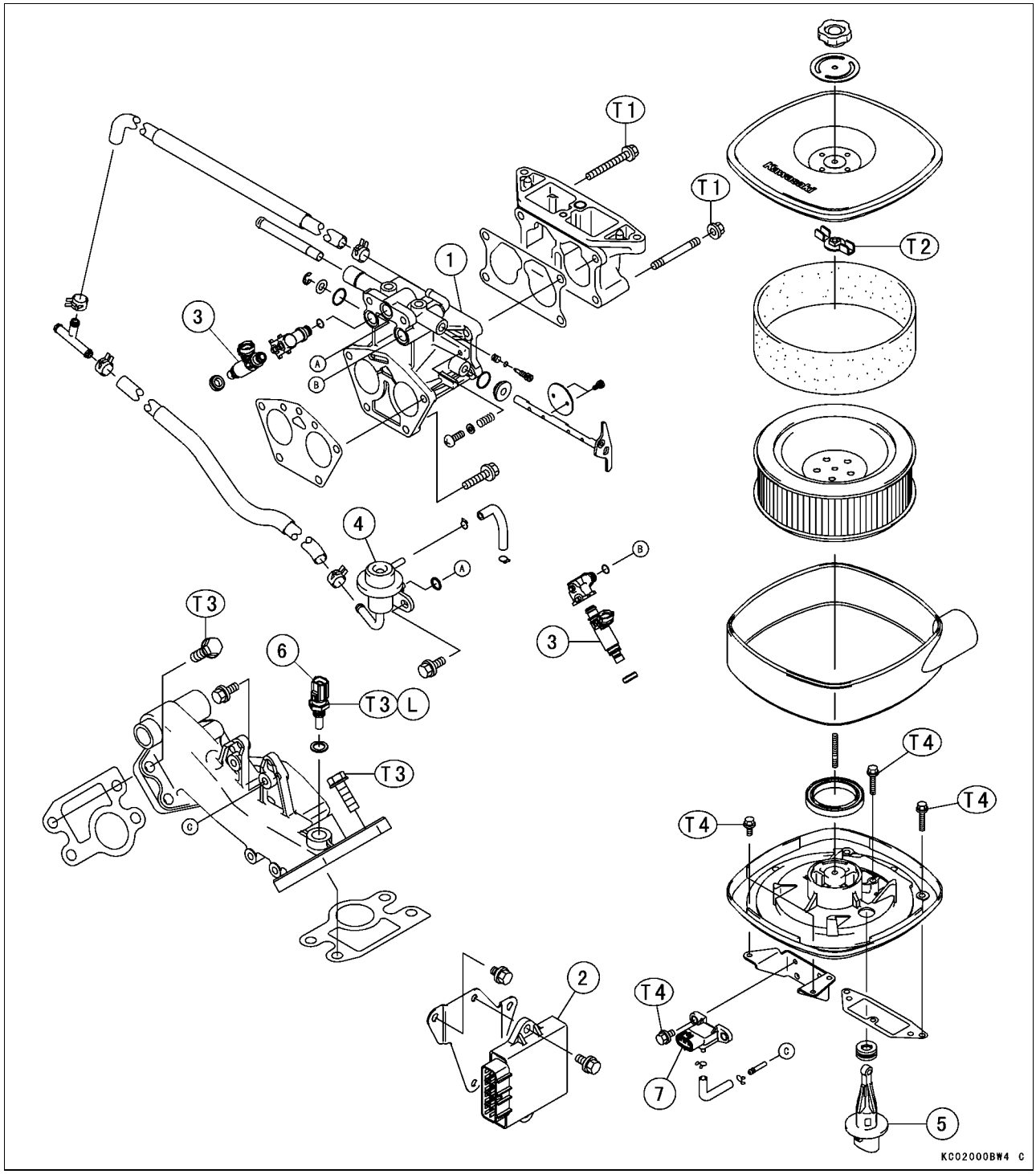
1. Pilot Screw Assy
2. Pilot Jet
3. Main Jet (#105)
4. Main Jet (#105)

T1: 0.7 N·m (0.07 kg·m, 6 in·lb)
T2: 2.0 N·m (0.2 kg·m, 17 in·lb)
T4: 9.8 N·m (1.0 kg·m, 87 in·lb)
T5: 12 N·m (1.2 kg·m, 106 in·lb)
T6: 20 N·m (2.0 kg·m, 15 ft·lb)
T7: 1.7 N·m (0.17 kg·m, 15 in·lb)
T8: 3.0 N·m (0.3 kg·m, 27 in·lb)

2-4 FUEL SYSTEM

Exploded View

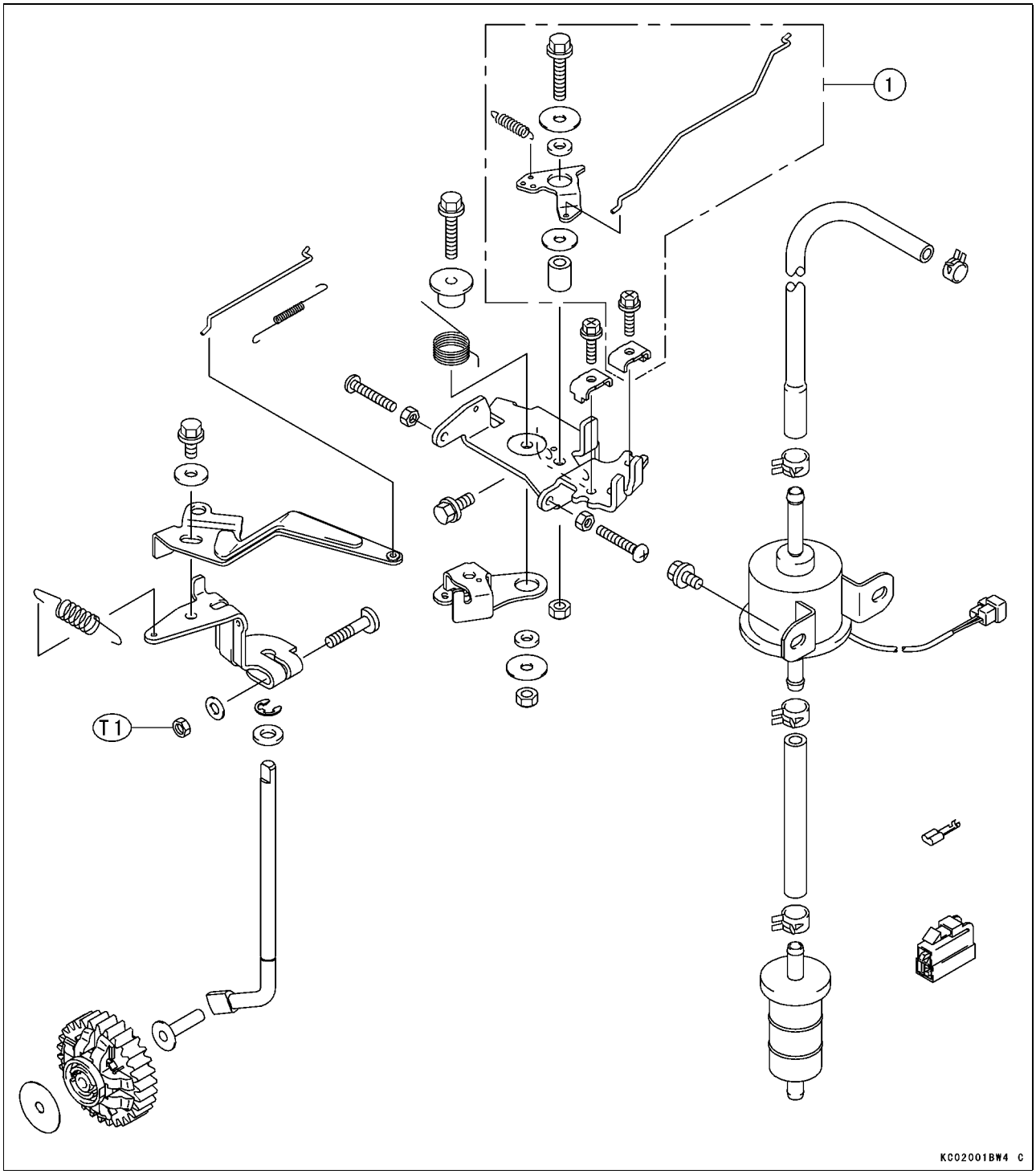
FD791D (DFI Model)



1. Throttle Body Assy
2. Electrical Control Unit (ECU)
3. Fuel Injectors
4. Fuel Pressure Regulator
5. Inlet Air Temperature Sensor
6. Water Temperature Sensor
7. Vacuum sensor

T1: 12 N·m (1.2 kg·m, 106 in·lb)
T2: 3.0 N·m (0.3 kg·m, 27 in·lb)
T3: 20 N·m (2.0 kg·m, 15 ft·lb)
T4: 9.8 N·m (1.0 kg·m, 87 in·lb)

Exploded View



1. Other than DFI Model

T1: 8 N·m (0.8 kg·m, 69 in·lb)

2-6 FUEL SYSTEM

Specifications

Item	Standard		
	FD671D	FD711D	FD750D
Caburetors Specifications:			
Make/ type	MIKUNI BW26	←	←
Throttle bore diameter	26 mm (1.02 in.)	←	←
Venturi diameter	20 mm (0.79 in.)	←	21 mm (0.83 in.)
Main Jet (MJ)	[R]: #102.5, [L]: #105	[R]: #110, [L]: #111.3	[R] and [L]: #106.3
Pilot jet (PJ)	[R] and [L]: #41.3	[R] and [L]: #45	[R] and [L]: #43.8
Main air jet (MAJ)	ø1.5	←	ø1.7
Pilot air jet (PAJ)	ø0.8	←	←
Pilot air screw turns out (PS) (Idle mixture screw turns out)	[R]: 2, [L]: 2–1/4	[R]: 1–7/8, [L]: 1–3/4	[R]: 2–1/4, [L]: 2–3/8
Float level	Float parallel to carburetor body		
Idle Speed: (1)			
Low idle speed	1550 rpm		
High idle speed	3600 rpm		
Air Cleaner:			
Type	Dual stage filtration system		
Pre-cleaner	Foam element		
Two-stage cleaner	Paper element		
Fuel:			
Fuel requirement	Unleaded regular grade gasoline		
Fuel Pump:			
Type	Electro-magnetic Pump (in-line type)		
Rated voltage	12 VDC		
Delivery (MIN)	400 mL (0.4 qt) / (MIN) at free flow		
Shut-off deliver pressure	19.6 to 26.5 kPa (2.8 to 3.8 psi)		
Governor:			
Type	Flyweight all speed governor		

(1) Idle speeds may vary depending on each equipment. Refer to the equipment specification.
[R] means the right-side parts viewed from the choke valve.
[L] means the left-side parts viewed from the choke valve.

Specifications

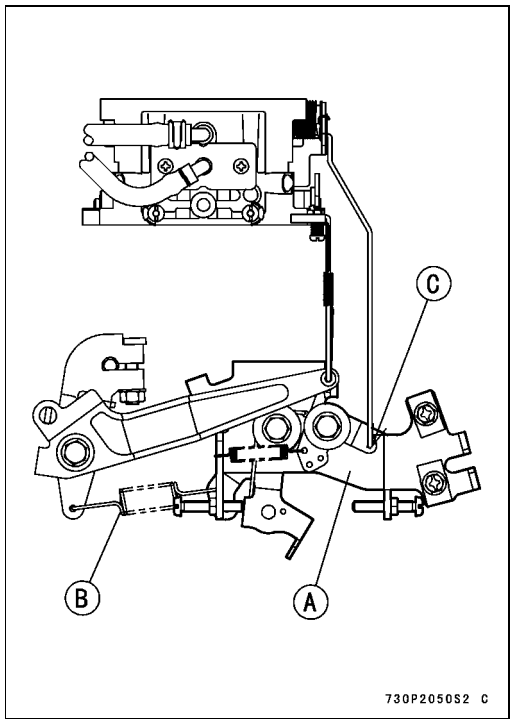
Item	Standard
	FD791D (DFI Model)
Digital Fuel Injection System	
Idle Speed	
Low idle speed	1550 rpm
High idle speed	3600 rpm
Throttle Body Assy	
Type	Two barrel type
Bore	20 mm (1.02 in)
ECU (Electronic Control Unit)	
Type	Digital memory type, sealed wih resin
Usable engine speed	200 ∼ 4000 rpm
Pressure Regulator	
Regulated fuel pressure	177 ± 5 kPa (1.8 ± 0.05 kg/cm^2, 25.6 ± 0.7 psi)
Vaccum Pressure Sensor:	
Input voltage	4.75 ∼ 5.25 V DC between BR/W and BK/R terminal
Output voltage	3.46 ∼ 3.82 V DC at standard atmospheric pressure (see this text for details)
Inlet Air Temperature Sensor	
Resistance	5.29 ∼ 6.47 kΩ at 0°C (32°F)
	2.21 ∼ 2.69 kΩ at 20°C (68°F)
	0.133 ∼ 0.163 kΩ at 80°C (176°F)
Water Temperature Sensor	
Resistance	2.21 ∼ 2.69 kΩ at 20°C (68°F)
	0.290 ∼ 0.354 kΩ at 80°C (176°F)
	0.133 ∼ 0.163 kΩ at 110°C (230°F)
Fuel Injectors	
Nozzle type	One spray type with 4 holes
Resistance	12.5 Ω at 20°C (68°F)
Fuel Pump	
Type	Electro magnetic pump (in-line type)
Discharge	120 mL or more/3 seconds at high idle speed (3600rpm)

Governor Link Mechanism

Control Panel Assembly Removal

- Remove:
  Air Cleaner (see Air Cleaner Body Removal)
  Muffler (see Muffler Assembly Removal)
  Control Panel Mounting Bolts [A]

- Remove the control panel assembly [A] while unhooking the governor spring [B] end loop at the panel bracket.
- Clear the choke link rod end [C] from the choke lever.

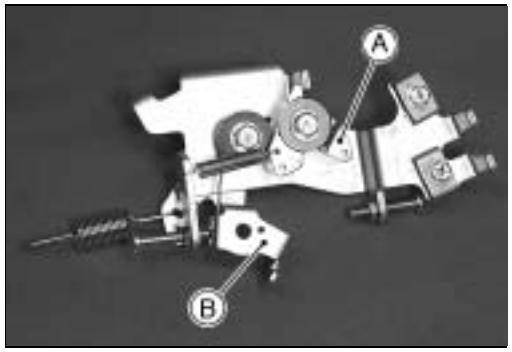


Control Panel Assembly Installation

- Before installing the control panel assembly, check to see that the choke lever [A] and engine speed control lever [B] move smoothly in all directions.

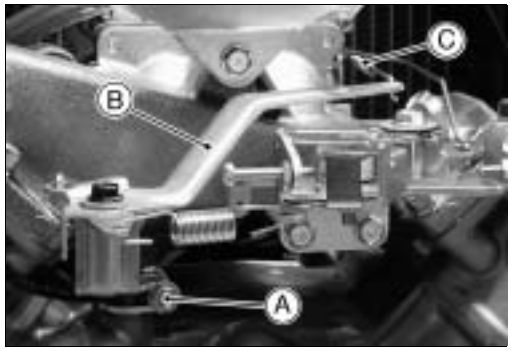
★If any part is worn or damaged, replace the control panel assembly.

- After installation, adjust the low idle speed and high idle speed to the specifications (see Low Idle Speed and High Idle Speed Adjustment).



Governor Arm Removal

- Remove:
  Control Panel Assembly
- Loosen the clamp nut [A] and take off the governor arm [B].
- Clear the throttle link rod [C] from the governor arm and choke lever.



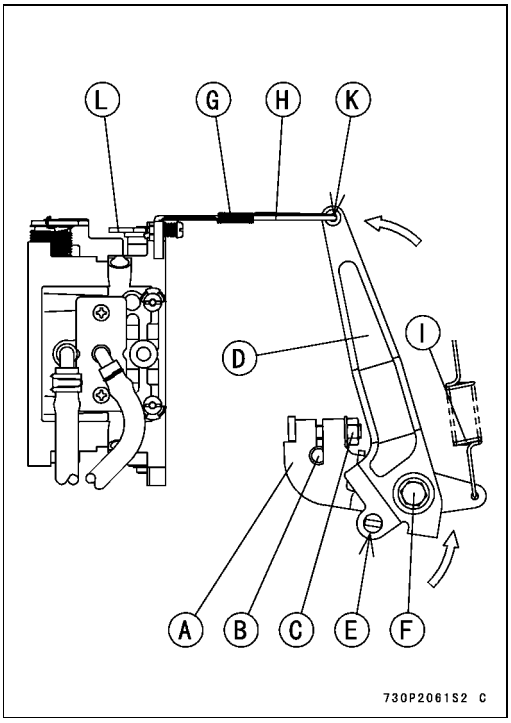
Governor Link Mechanism

Governor Arm Installation

- Insert the bracket [A] onto the governor shaft [B] thoroughly to the bottom of the woodruff area of the shaft, and tighten the clamp nut [C].

Torque - Governor Arm Clamp Nut: 8 N·m (0.8 kg·m, 69 in·lb)

- Install the control panel assembly, and connect the bracket with the governor spring [I].
- Install the end of throttle link rod [H] with the link spring [G] around it into the governor arm hole [K] and the other end into carburetor throttle lever [L] hole.
- Be sure the link spring around the throttle link rod is in place and that it pulls the governor arm and throttle lever each other.
- Install the governor arm [D] on the bracket [A] with the bolt [F] and washer by turning the bolt counterclockwise so the projection of the bracket fits into the governor arm hole [E].
- Loosen the bolt [F], and fully turn the bracket [A] counterclockwise and hold it there.
- Turn the top end of the governor arm [D] counterclockwise to fully open the carburetor throttle valve and tighten the bolt [F].

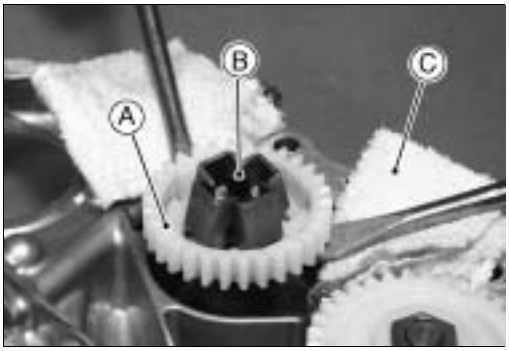


Governor Assembly Removal

- Remove:
  Crankcase Cover (see Camshaft/Crankshaft chapter)
- Remove the governor assembly [A] with the sleeve [B] by prying the gear with two proper size screw drivers.

NOTE

○ *To avoid damage to the surface of crankcase cover, use a suitable soft mats [C] as shown.*



CAUTION

Do not remove the governor assembly unless it is necessary. Once it has been removed, it must be replaced.

- Remove the thrust washer.

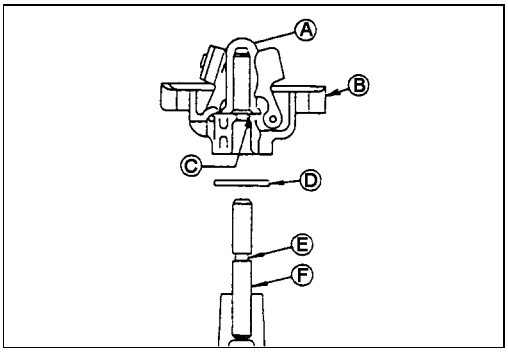
Governor Assembly Installation

- Fit the sleeve into the governor assembly, and install them as a set.

NOTE

○ *The sleeve and the governor assembly cannot be installed separately. Push the set onto the shaft until inner flange snaps into the groove securely.*

Sleeve [A]
Governor Assembly [B]
Inner Flange [C]
Thrust Washer [D]
Groove [E]
Shaft [F]



- Spin the governor assembly by hand and check that the flyweights operate freely and the center sleeve moves outward.

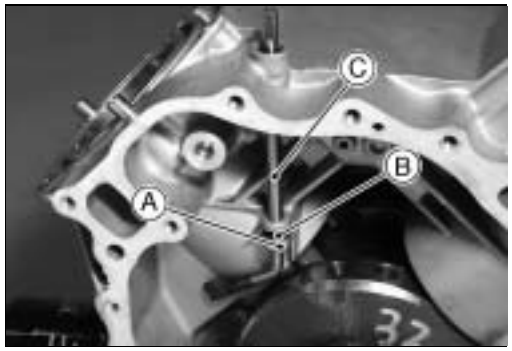
Governor Assembly Inspection

○ Visually check the assembly for wear and damage.
★ If any parts is worm or damaged, replace the assembly.

Governor Link Mechanism

Governor Shaft Removal

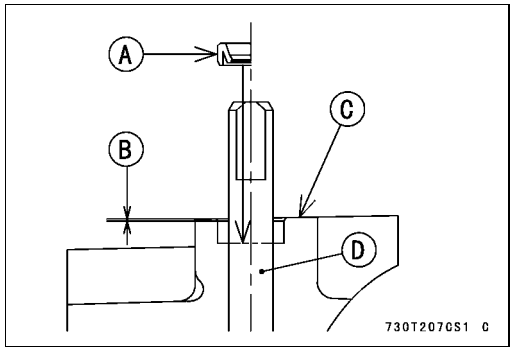
- Remove:
  Camshaft (see Camshaft/Crankshaft chapter)
- Unscrew the governor arm clamp nut, and remove the governor arm.
- Remove the circlip [B] on the governor shaft [C], and remove the governor shaft and washer [A].



NOTE

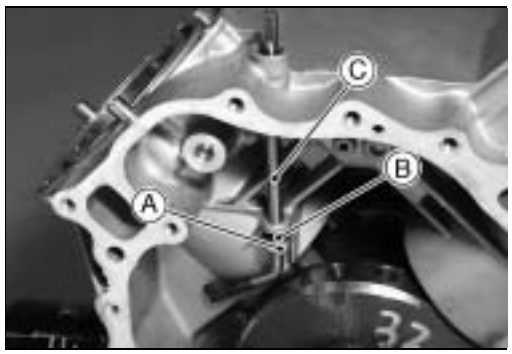
○ *It is not necessary to remove the governor shaft unless it is being replaced.*

- Replace the oil seal only if the lip shows signs of leakage or it has been damaged.
- The oil seal [A] must be assembled with seal lip towards inside of the engine.
- Press in the oil seal 0 ~ 1.0 mm (0.04 in.) [B] flush or below the crankcase surface [C].
  [D] Governor Shaft



Governor Shaft Installation

- Apply engine oil to the governor shaft.
- Insert the governor shaft into the crankcase and washer [A].
- Fit the circlip [B] securely into the groove of governor shaft [C] as shown.
- Check that the governor shaft moves freely in its operating range.



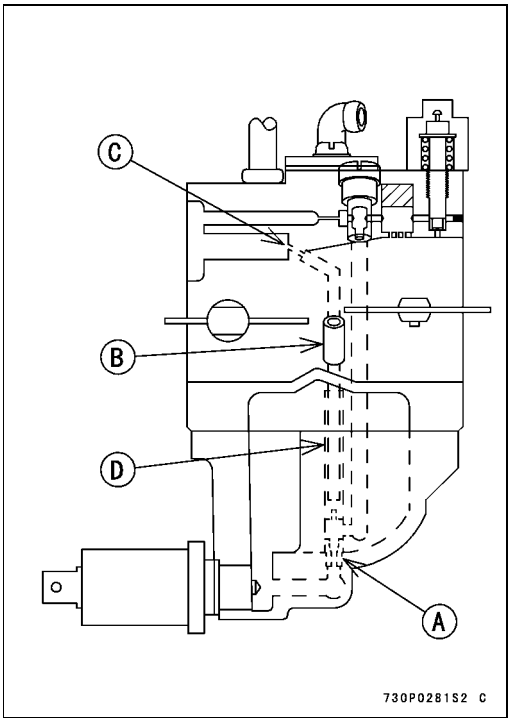
NOTE

○ *If the oil seal is removed, reinstall it after the shaft is installed.*

Carburetor

Fuel and Air Flow

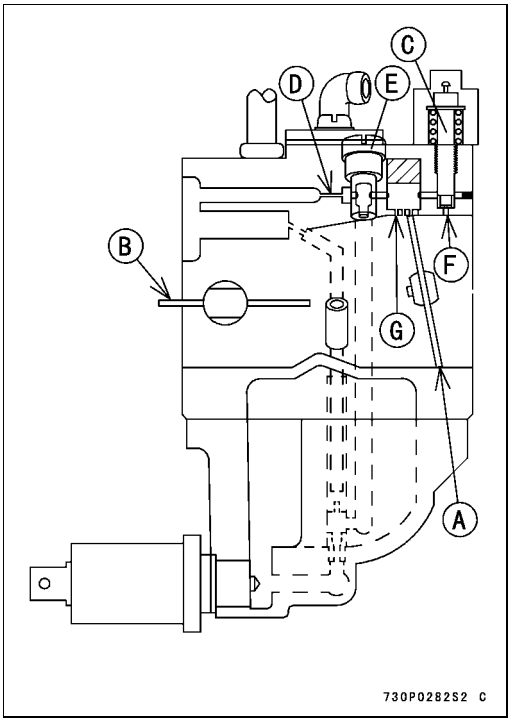
The main system of the carburetor consists of the main jet [A], main nozzle [B], and the main air passage (main air jet) [C]. The main system meters fuel to the engine during moderate to heavy load conditions. Fuel flows through the main jet and into the bleed pipe [D], where it is joined by air from the main air passage (main air jet). The resulting mixture flows out the end of the main nozzle into the carburetor bore, where it is atomized by the high speed air flow, and carried into the engine.



The pilot system includes the pilot jet [E], pilot screw (idle mixture screw) [C], pilot air jet [D], pilot outlet [F], and the bypass holes [G]. The pilot system meters the fuel/air mixture while the engine is idling and running under a light lead. Under these conditions there is very little air flow through the carburetor bore; so little that it is not enough to draw fuel through the main system of the carburetor and atomize it. Instead, the fuel is drawn through the pilot system, since the nearly closed throttle valve [A] causes high speed air flow past the pilot outlet and bypass holes (even at low engine speed).

B. Choke Valve

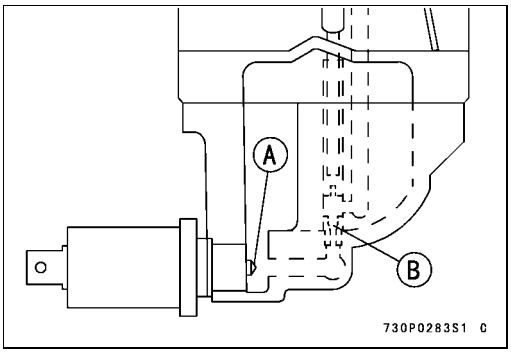
Fuel flow in the pilot system is metered by the pilot jet. Air for better atomization is admitted via the pilot air jet in the mid-way of the carburetor. The fuel/air mixture passes into the bore of the carburetor downstream of the throttle valve through the bypass holes and pilot outlet. While the throttle valve is almost closed, it covers the small bypass holes opening into the bore from the pilot system. As the throttle valve begins to open, it uncovers the bypass holes, allowing more fuel/air mixture to flow. The extra flow is needed because the engine starts to run faster as the throttle is opened. The pilot screw controls the amount of fuel/air mixture allowed through the pilot outlet, but dose not meter the bypass holes. A moderate amount of air comes in around the throttle valve at an idle, so adjusting the pilot screw changes the fuel/air ratio. Turning the pilot screw (idle mixture screw) out (counterclockwise) enriches the mixture; turning it in (clockwise) leans the mixture.



Fuel Shut Off Solenoid Valve

To avoid after firing when stopping the engine, a solenoid actuated fuel shut off solenoid valve [A] is installed in the carburetor bowl. The valve shuts off the fuel supply to the main jet [B] simultaneously when the switch key turned to the “OFF” position.

The valve opens automatically when the switch key is turned to the “Run” position.



Carburetor

Low Idle Speed Adjustment

- Disconnect all possible external loads from the engine.
- Start the engine and warm it up thoroughly.

⚠ WARNING

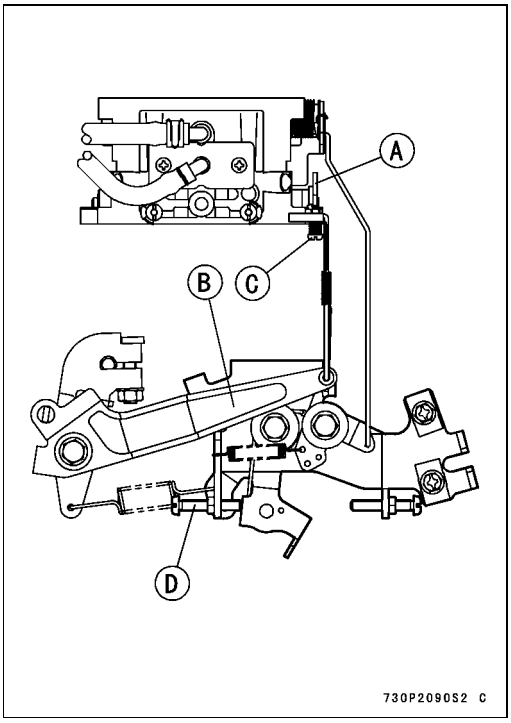
Always keep your hands clear of the moving parts.

- Move the throttle lever on dash to the idle position.
- Hold the throttle lever [A] on the carburetor in closed position (turn the governer arm [B] clockwise all the way), and adjust the low idle speed screw [C] until the engine idles at specified speed.

Idle Speed (Carburetor idle rpm)
1450 rpm

- Release the throttle lever and adjust the low idle speed set screw [D] on the control plate to obtain the specified governed low idle speed.

Low Idle Speed (Governed idle rpm)
1550 rpm



High Idle Speed Adjustment

NOTE

○ *High idle speed adjustment should be made after the idle speed adjustment is performed.*

CAUTION

Do not adjust high idle speed with the air cleaner removed.

- Start and warm up the engine thoroughly.

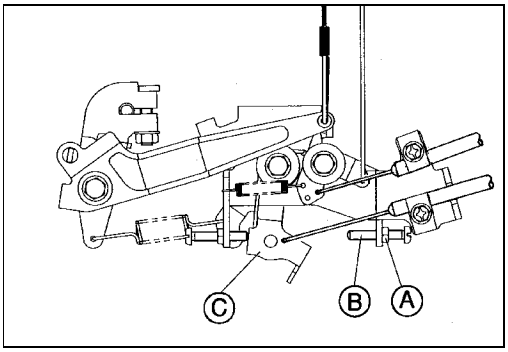
⚠ WARNING

Always keep your hands clear of the moving parts.

- Loosen the lock nut [A], and unscrew the high idle set screw [B] few turns.
- Move the throttle lever on dash to obtain the specified high idle speed and leave it there.

High Idle Speed
3 600 rpm

- Turn the high idle set screw [B] so that the end of it just touches the speed control lever [C], and tighten the lock nut [A].
- Check the idle speed, and readjust the idle speed if necessary.



CAUTION

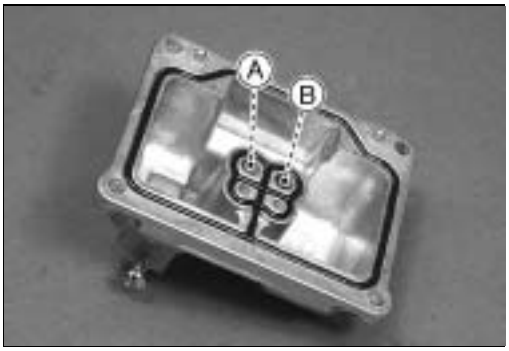
Be sure to make the idle and fast idle speeds respectively correspond to those of the equipment.

Carburetor

High Altitude Operation

At high altitude, the standard carburetor air-fuel mixture will be excessively rich. Performance will decrease, and fuel consumption will increase. High altitude performance can be improved by installing a smaller diameter main-jet in the carburetor and correct idle speed.

[A] Main-jet [R]
[B] Main-jet [L]



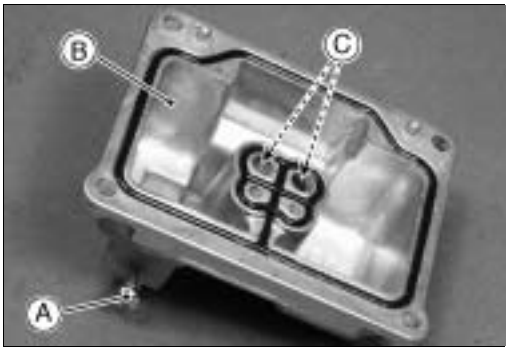
NOTE

○ *The main jet high altitude kits are available if the equipment is to be used in the high altitudes. The main jet numbers are stamped on ends of the main jets.*

High Altitude Main Jet

Altitude	Main Jet No.		
	FD671D	FD711D	FD750D
0 ∼ 1 000 m (0 ∼ 3 000 ft)	R: #102.5 L: #105	R: #110 L: #111.3	R and L: #106.3
1 000 ∼ 2 000 m (3 000 ∼ 6 000 ft)	R: #100 L: #102.5	R: #107.5 L: #108.8	R and L: #103.8
2 000 m (6 000 ft) and higher	R: #97.5 L: #100	R: #105 L: #106.3	R and L: #101.3

Main Jet Replacement



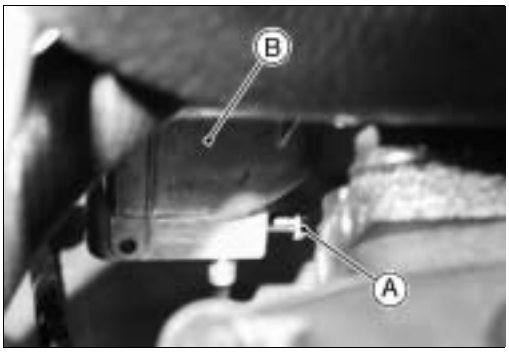
- Place the engine (equipment) on a level surface.
- Close the fuel shut off valve in the equipment.
- Drain the fuel in the carburetor completely by unscrewing the drain screw [A] at the bottom of the float chamber.
- Remove the carburetor (see Carburetor Removal).
- Unscrew the float chamber screws and take off the float chamber [B].
- Using a proper blade screw driver, carefully replace the main jet [C] with a new one for altitude expected.
- Tighten the main jet to the specification (see Carburetor Disassembly Assembly Notes).

Torque - Main Jet: 0.7 N·m (0.07 kg·m, 6 in·lb)

- Install the gasket and float chamber.

Torque - Float Chamber Mounting Screw: 2.0 N·m (0.20 kg·m, 17 in·lb)

Fuel System Cleanliness Inspection



⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Place a suitable pan under the drain screw [A] on the carburetor [B].
- Turn out the drain screw a few turns to drain the carburetor and check to see if water or dirt has accumulated in the carburetor.
- Tighten the drain screw.
- If any water or dirt come out, clean the carburetor (see Carburetor Cleaning), and fuel tank, and check the fuel filter.

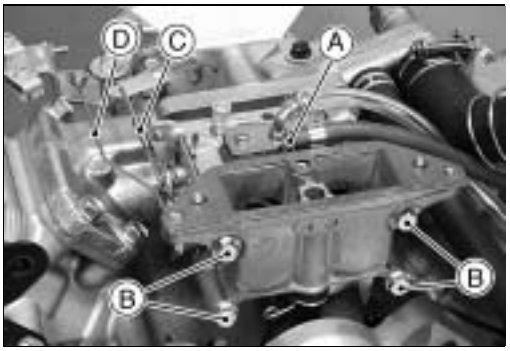
Carburetor Removal

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

Carburetor

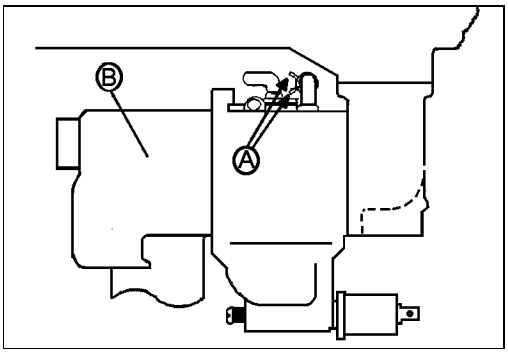
- Remove:
  Air Cleaner and Related Parts (see Air Cleaner Removal)
  Radiator (see Radiator Removal)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal)
- Turn the fuel shut off valve to the OFF position.
- Drain the carburetor.
- Disconnect the fuel tube at the fuel inlet joint [A] of the carburetor.
- Disconnect the solenoid valve lead terminal.
- Unscrew the intake pipe and carburetor mounting bolts [B].
- Unhook the throttle [C] and choke link rod [D] at the ends of their arms while pull off the carburetor.



Carburetor Installation

- Clean the mating surfaces of the carburetor, insulator and intake pipe, and fit new gaskets.
- Take care not to bend the throttle and choke link rods during installation.
- Install the gaskets, insulator, carburetor and intake pipe with mounting bolts and tighten them.

Torque - Carburetor and Intake Pipe Mounting Bolts: 12 N·m (1.2 kg·m, 106 in·lb)



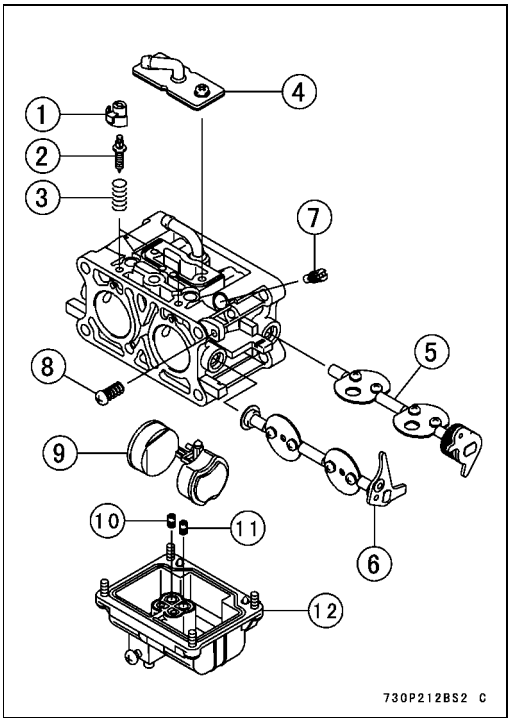
- Be sure the fuel tube clip ends [A] face toward the intake-manifold [B] as shown.
- Adjust idle speed.

Carburetor

Carburetor Disassembly/Assembly

- Refer to the illustration shown for disassembly and assembly.
- There are several passage plugs (ball plugs) in the carburetor body. Do not remove.
- Before disassembly, mark the out side of choke valve and throttle valves for assembling them.

1. Limiter
2. Pilot Screw
3. Spring
4. Cover Assy
5. Choke Valve Assy
6. Throttle Valve Assy
7. Pilot Jet
8. Screw
9. Float Assy
10. Main Jet (R)
11. Main Jet (L)
12. Float Chamber Assy



- Replace the pilot screw in accordance with the following procedure if necessary.
  - ○ Carefully mark the position of the pilot screw limiter on the carburetor body so that it can be installed and set to its original position later.
  - ○ Remove the limiter. Be careful not to turn pilot screw at this point.
  - ○ Turn the pilot screw clockwise and count the number of turns until screw is gently seated in the pilot passage. Record the number of turns needed to closed the screw.
  - ○ Turn out the pilot screw to replace it with a new one.
  - ○ Install the new pilot screw until the screw is gently seated. Then open the screw the same number of turns as recorded prior to removal.
  - ○ Align the limiter with the mark on the carburetor body to install, taking care not to turn the pilot screw.
- Install the choke valve and throttle valve on the shaft as the out side mark of them facing out side.
- Drive in the float pin so that the pin extends the same distance on both side of the float hinge bracket.
- The fuel inlet valve seat is pressed into the carburetor body and is not replaceable.
- When assembling the carburetor parts which are attached to the carburetor with the recommended tightening torque of a bolts and screws. (see Exploded View)

Carburetor

Carburetor Cleaning

⚠ WARNING

Clean the carburetor in a well-ventilated area, and take care that there is no spark or flame anywhere near the working area; this include any appliance with a pilot light. Because of the danger of highly flammable liquids, do not use gasoline or low flash-point solvents to clean the carburetors.

CAUTION

Do not use compressed air on an assembled carburetor, the float may be crushed by the pressure. Remove as many rubber or plastic parts from the carburetor as possible before cleaning the carburetor with a cleaning solution. This will prevent damage or deterioration of the parts. The carburetor body has plastic parts that cannot be removed. Do not use a strong carburetor cleaning solution which could attack these parts; instead, use a mild high flash-point cleaning solution safe for plastic parts. Do not use wire or any other hard instrument to clean carburetor parts, especially jets, as they may be damaged.

- Disassemble the carburetor.
- Immerse all the carburetor metal parts in a carburetor cleaning solution and clean them.
- Rinse the carburetor parts in water and dry them with compressed air.
- Do not use rags or paper to dry parts. Lint may plug the holes or passages.
- Blow air through the holes and fuel passages with the compressed air. All holes must be open.
- Assemble the carburetor.

Carburetor Inspection

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Inspect the carburetor body for damage. Flange sealing surfaces should be smooth and free of burrs and nicks. Replace the gasket if necessary.
- Turn the throttle and choke shafts to check that the throttle and choke butterfly valves move smoothly.

★If the valves do not move smoothly, replace the carburetor body and/or throttle shaft and choke shaft assembly.

- Check that the gasket on the float chamber.

★If the gasket is not in good condition, replace it.

- Check the other parts of the carburetor for wear or damage. Replace the part if necessary.
- Clean and check the float level as follows.

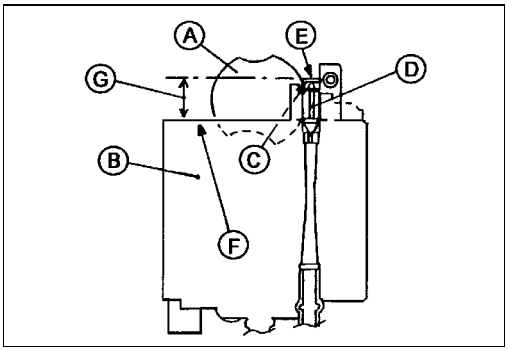
CAUTION

Do not push down on the float during float level checking.

Carburetor

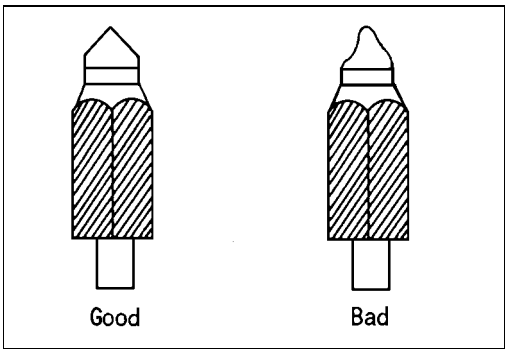
- With the float [A] assembly installed onto the carburetor body [B], hold the carburetor upside down at an eye level. Gently support the float with a finger and bring it down slowly so that the float arm tab [C] just touches the float valve [D]. The float arm surface [E] should be parallel [G] with the carburetor body mating surfaces [F].

★If the float position is not correct, bend the tab as required for correct adjustment.



- Inspect the float valve for excessive wear or damage. The tip should be smooth, without any grooves, scratches, or tears. The rod at the other end of the needle should move smoothly when push in and released.

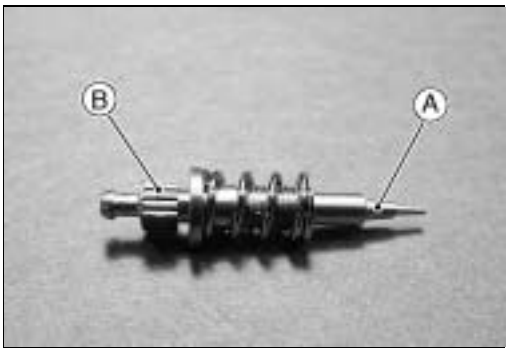
★If either the valve or the seat is worn or damaged, replace the float assembly and carburetor body as a set.



- Inspect the tapered portion [A] of the pilot screw [B] for wear or damage.

★If the pilot screw is worn or damaged on the taper portion, replace it.

- Check the spring for weakened condition, replace it, if necessary.



Fuel Shut-Off Solenoid Valve Test

- Unscrew the fuel shut off valve and remove the valve.
- Connect a 12 VDC source to the solenoid as shown.

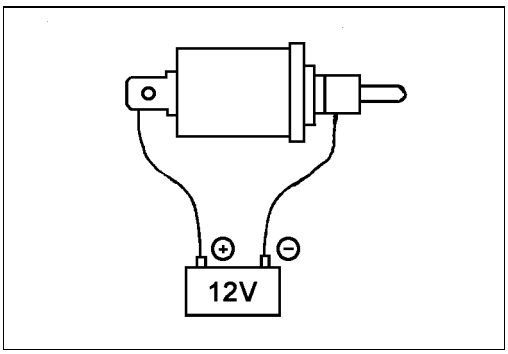
★If the actuate solenoid plunger (needle valve) does not pop in when the test voltage is applied, replace it.

NOTE

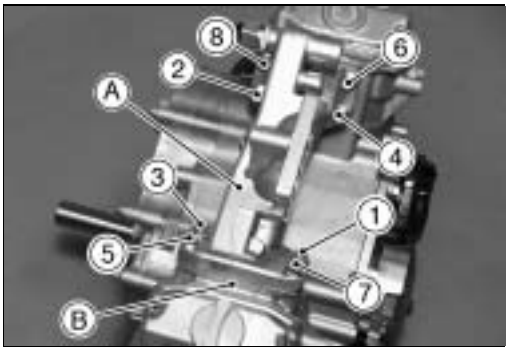
○ *If may be necessary to push the plunger slightly for the plunger to withdraw.*

- Install the gasket and the valve.

Torque - Fuel Shut-Off Solenoid Valve: 7 N·m (0.7 kg·m, 61 in·lb)



Intake Manifold



Intake Manifold Removal

- Remove:
  Air Cleaner (see Cleaner Body Removal)
  Carburetor
  Control Panel Assembly
- Drain the coolant in the engine (see Coolant Draining).
- Unscrew the manifold mounting bolts in numerical sequence, 1/4 turn at a time, until all bolts are loose.

★If the mounting bolts removal sequence is not followed, manifold mating surfaces may be warped.

- Remove the manifold [A] and gaskets [B].

Intake Manifold Installation

- Before assembling the manifold, install the cylinder heads on each cylinder and tighten the head bolts (see Cylinder Head Installation).
- Place a new gaskets on each mating surface, and install the manifold.
- Tighten the manifold mounting bolts in sequence 3 N·m (0.31 kg·m, 26 in·lb) at a time until the torque on each bolt is 20 N·m (2.0 kg·m, 15 ft·lb).

Torque - Intake Manifold Mounting Bolts: 20 N·m (2.0 kg·m, 15 ft·lb)

Intake Manifold Inspection

- Visually inspect the coolant passage in the manifold for deposits or corrosion in layers inside the passage, clean the passage if necessary.
- An improperly installed gaskets can cause coolant leakage and air drawn into the induction passage. Check the gaskets for correct installation.

NOTE

○ *Small coolant leaks appear only as a rust, corrosion or stain.*

- Inspect the intake manifold for cracks or porous casting.
- Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25% kerosene and 75% light engine oil.
- Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a cracks is present, the coating will become discolored at the defective area.

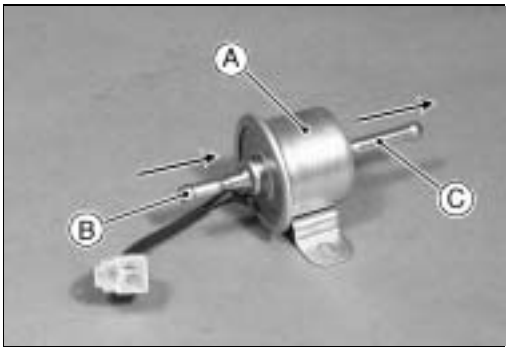
★If a crack is present in the intake manifold, replace it.

- Inspect the gasket surfaces for burrs and nicks.

Fuel Pump

The fuel pump cannot be disassembled, if any damage for the pump is appeared replace it with a new one.

[A] Fuel Pump
[B] Inlet Pipe
[C] Outlet Pipe



Fuel Pump Test

Before this test, be sure the battery is fully charged.

⚠ WARNING

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- Disconnect and plug the fuel pump outlet pipe.
- Connect proper pressure gauge to the fuel pump outlet pipe.
- Turn the engine switch to the "RUN" position, the fuel pump will operates. Record the pressure reading. Stop the fuel pump.
- Remove the pressure gauge and connect the outlet fuel tube.
- Disconnect the fuel pump outlet tube from the carburetor inlet.
- Put the tube end in a graduated container.
- Run the fuel pump for 30 seconds. Stop the fuel pump. Record the container measurement.
- Compare the readings to the specifications.

★If low, check for clogged or damaged tubes, fuel filter, or fuel tank. Replace faulty fuel pump.

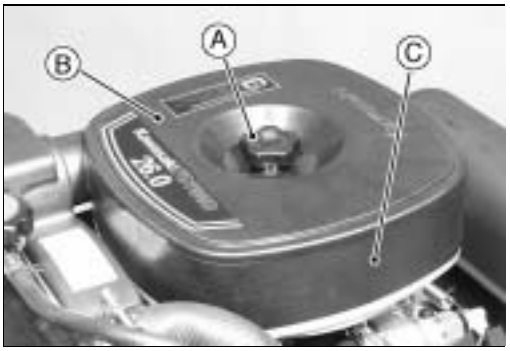
Minimum Specifications

Fuel Pressure	**19 kPa (2.76 psi)**
Fuel Flow	**180 mL/30 seconds**

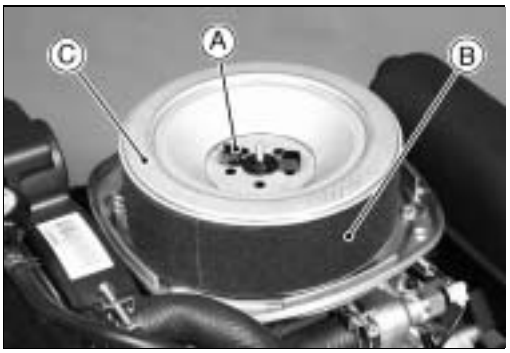
Air Cleaner

Element Removal

- Remove:
  Air Cleaner Case Nut [A]
  Upper-case [B]
  Cleaner Case [C]



- Remove:
  Wing Nut [A]
  Foam Element [B]
  Paper Element [C]



Element Installation

- Install the element correctly on the air cleaner body.
- Be sure the paper element is in-place in the air cleaner body.
- Be sure the foam element is in-place on the paper element body.

Element Cleaning and Inspection

NOTE

○ *In dusty areas, the elements should be cleaned more frequently than the recommended intervals.*

⚠WARNING

Because of the danger of highly flammable liquids, do not use gasoline or a low flash-point solvent to clean the element.

- Remove the foam element [A] and the paper element [B].
- Clean the foam element [A] in a bath of detergent and water, and let the element air-dry thoroughly before install it.

- Clean the paper element [B] by tapping it gently on a flat surface to remove dust. If the element is very dirty, replace it with a new one.

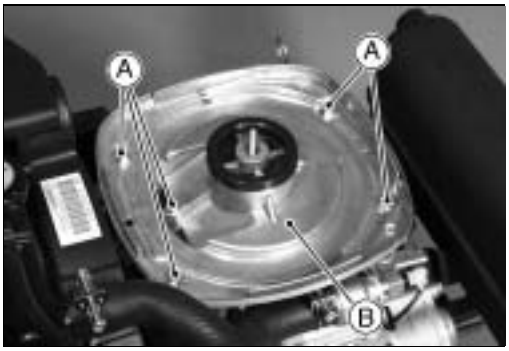
CAUTION

Do not use compressed air to clean the paper element. Do not oil the paper or foam element.

Air Cleaner

Cleaner Body Removal

- Remove the elements. (see Element Removal)
- Remove the cleaner body mounting bolts [A] and take off the cleaner body [B].



Cleaner Body Installation

- Replace the intake pipe gasket [A] with a new one.
- Clean the mating surface of the cleaner body and intake pipe.
- Install the cleaner body on the intake pipe and bracket.
- Tighten the mounting bolts.

Torque - Cleaner Body Mounting Bolts: 9.8 N·m (1.0 kg·m, 87 in·lb)

Housing (Case and Body) Inspection

- Clean the housing with detergent and water and dry thoroughly.
- Check the housing for deformation or other damage. The housing must seal well and permit only filtered air to reach the carburetor.

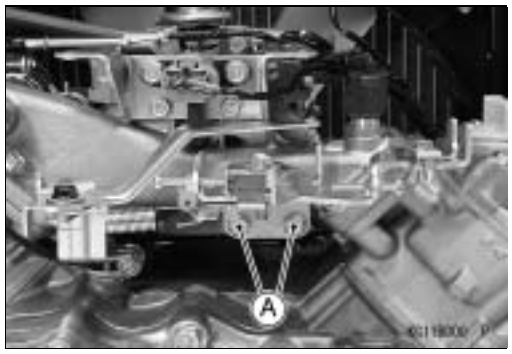
★If the housing is damaged, it must be replaced.

- Check that no foreign material is obstructing the air passage.

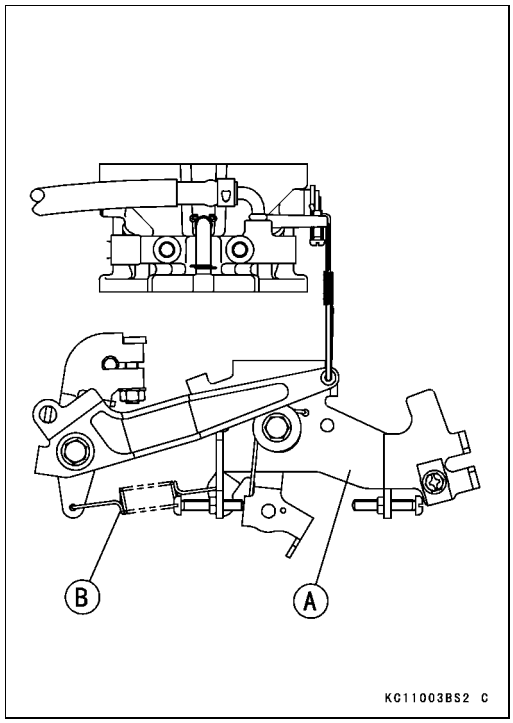
Governor Link Mechanism

Control Panel Assembly Removal

- Remove:
  Air Cleaner (see Air Cleaner Body Removal)
  Muffler (see Muffler Assembly Removal)
  Control Panel Mounting Bolts [A]

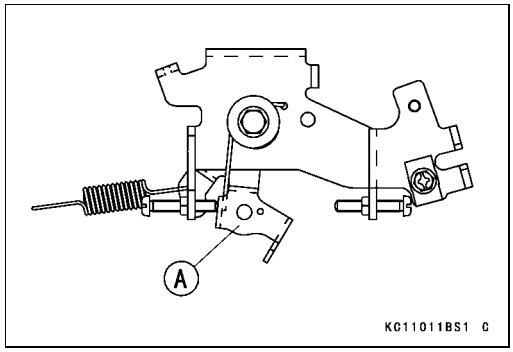


- Remove the control panel assembly [A] while unhooking the governor spring [B] end loop at the panel bracket.



Control Panel Assembly Installation

- Before installing the control panel assembly, check to see that the engine speed control lever [A] move smoothly in all directions.
- ★If any part is worn or damaged, replace the control panel assembly.
- After installation, adjust the low idle speed and high idle speed to the specifications (see Low Idle Speed and High idle Speed Adjustment).



Governor Arm Removal

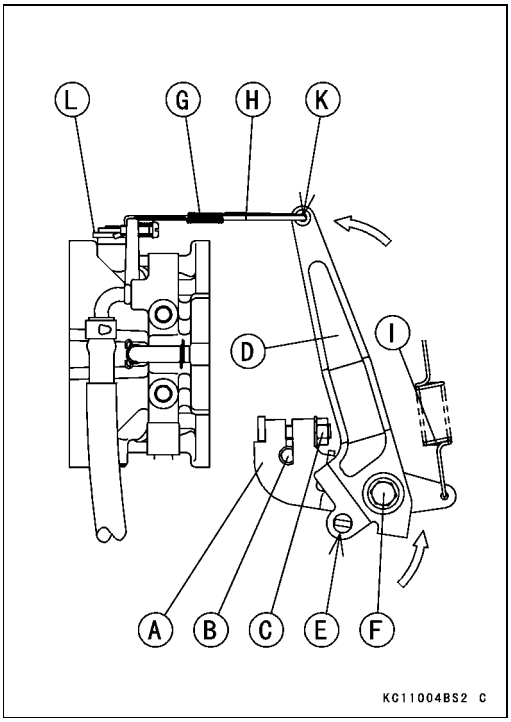
- Remove:
  Control Panel Assembly
- Loosen the clamp nut [A] and remove the governor arm [B].
- Clear the throttle link rod [C] from the governor arm.

Governor Arm Installation

- Insert the bracket [A] onto the governor shaft [B] thoroughly to the bottom of the woodruff area of the shaft, and tighten the clamp nut [C].

Torque - Governor Arm Clamp Nut: 8 N·m (0.8 kg·m, 69 in·lb)

- Install the control panel assembly, and connect the bracket with the governor spring [I].
- Install the end of the throttle link rod [H] with the link spring [G] around it into the governor arm hole [K], and the other end into the throttle body assy lever [L] hole.
- Be sure the link spring around the throttle link rod is in place and that it pulls the governor arm and throttle lever each other.
- Install the governor arm [D] on the bracket [A] with the bolt [F] and washer by turning the bolt counterclockwise so the projection of the bracket fits into the governor arm hole [E].
- Loosen the bolt (turn clockwise) [F], and fully turn the bracket [A] counterclockwise and hold it there.
- Turn the top end of the governor arm [D] counterclockwise to fully open the throttle body assy valve and tighten the bolt (turn counterclockwise) [F].



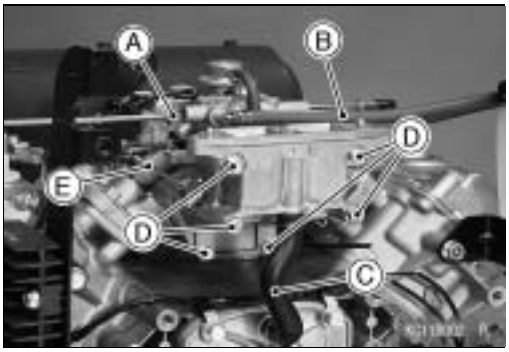
Throttle body Assy

Throttle Body Assy Removal

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Turn the ignition switch OFF. Do not smoke. Make sure the area is well ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light.

- Remove:
  Air Cleaner and Related Parts (see Air Cleaner Removal)
  Radiator (see Radiator Removal)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal)
  Fan Mounting Holder
- Turn the fuel shut off valve of the OFF position.
- Loosen the fuel pressure relief screw [A] to relieve the high pressure in the return fuel hose [B], then tighten it.
- Disconnect the fuel return fuel hose.
- Drain the fuel in the hoses into a suitable container.
- Disconnect the breather hose [C].
- Unscrew the intake pipe and throttle body assy mounting bolts and nuts [D].
- Unhook the throttle link rod [E] at both ends while together pulling off the throttle body assy and fuel pressure regulator.



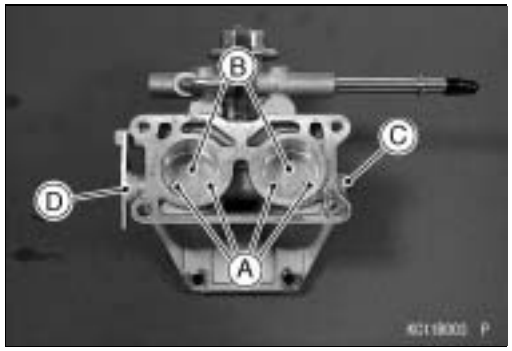
Throttle Body Assy Installation

- Clean the mating surfaces of the throttle body assy and intake pipe, and install new gaskets.
- Take care not to bend the throttle link rod during installation.
- Install the gaskets throttle body assy and intake pipe with mounting bolts and tighten them.

Torque - Throttle Body Assy and Intake Pipe Mounting Bolts: 12 N·m (1.2 kg·m, 106 in·lb)

- Be sure the fuel hoses are clamped securely to prevent leaks.
- Adjust idle speed.

Throttle Body Assy Disassembly



NOTE

○ *Do not attempt to remove the throttle valve and shaft unless they appear to be damaged.*

- Remove the throttle body assy.
- Remove the screws [A] and remove the throttle valves [B].
- Remove the circlip [C] and pull out the throttle shaft [D].

Throttle Body Assy Assembly

- Before assembling, throughly cleam the throttle body of dirt dust by applying compressed air.

NOTE

○ *Replace the dust seal of the throttle shaft with a new one.*

- Apply engine oil to the new dust seal insert the throttle shaft.
- Install the throttle shaft to the throttle body.
- Apply a non-permanent locking agent to the screws.
- Install the throttle valves and thighten them.

Torque - Throttle valve screws: 0.9 N·m (0.09 kg·m 7.8 in·lb)

○ After tightening the screws, be sure that the throttle valves is perfectly close in the bore and that the throttle shaft moves freely without any irregularities.

Low Idle Speed Adjustment

- Disconnect all possible external loads from the engine.
- Start the engine and warm it up thoroughly.

⚠ WARNING

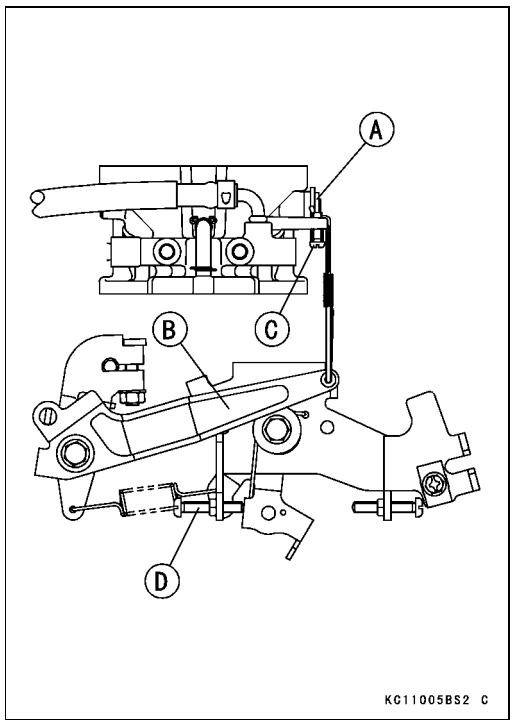
Always keep your hands clear of the moving parts.

- Move the throttle lever on the dash to the idle position.
- Hold the throttle lever [A] on the carburetor in closed position (turn the governor arm [B] clockwise all the way), and adjust the low idle speed screw [C] until the engine idles at specified speed.

Idle Speed (Carburetor idle rpm): 1450 rpm

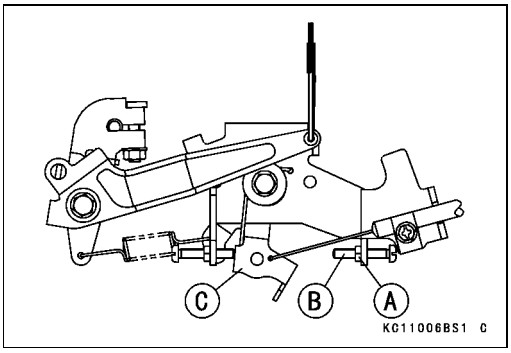
- Release the throttle lever and adjust the low idle speed set screw [D] on the control plate to obtain the specified governed low idle speed.

Low Idle Speed (Governed idle rpm: 1550 rpm



Digital Fuel Injection (DFI) System

High Idle Speed Adjustment



NOTE

○ *High idle speed adjustment should be made after the idle speed adjustment is performed.*

CAUTION

Do not adjust high idle speed with the air cleaner removed.

- Start and warm up the engine thoroughly.

⚠WARNING

Always keep your hands clear of the moving parts.

- Loosen the lock nut [A], and unscrew the high idle set screw [B] a few turns.
- Move the throttle lever on the dash to obtain the specified high idle speed and leave it there.

High Idle Speed: **3600 rpm**

- Turn the high idle set screw [B] so that the end of it just touches the speed control lever [C], and tighten the lock nut [A].
- Check idle speed, and readjust if necessary.

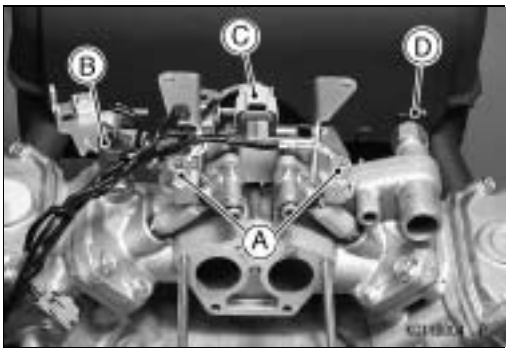
CAUTION

Be sure to make the idle and fast idle speeds respectively correspond to those of the equipment.

Intake Manifold (DFI)

Intake Manifold (DFI) Removal

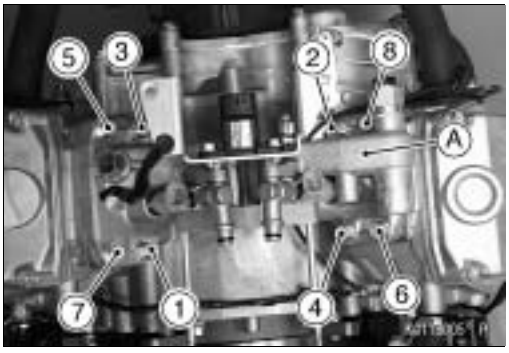
- Turn the ignition switch OFF.
- Remove:
  Air Cleaner (see Cleaner Body Removal)
  Throttle Body Assy (see Throttle Body Assy Removal)
  Control Panel Assembly
- Drain engine coolant (see Coolant Draining).
- Disconnect:
  Fuel Injector leads (#1, #2) [A]
  Water Temperature Sensor Lead [B]
  Vacuum Sensor Lead [C]
  Thermo Switch Lead [D]



- Unscrew the manifold mounting bolts in numerical sequence, 1/4 turn at a time, until all bolts are loose.

★If the mounting bolts removal sequence is not followed, manifold mating surfaces may be warped.

- Remove the manifold [A] and gaskets.



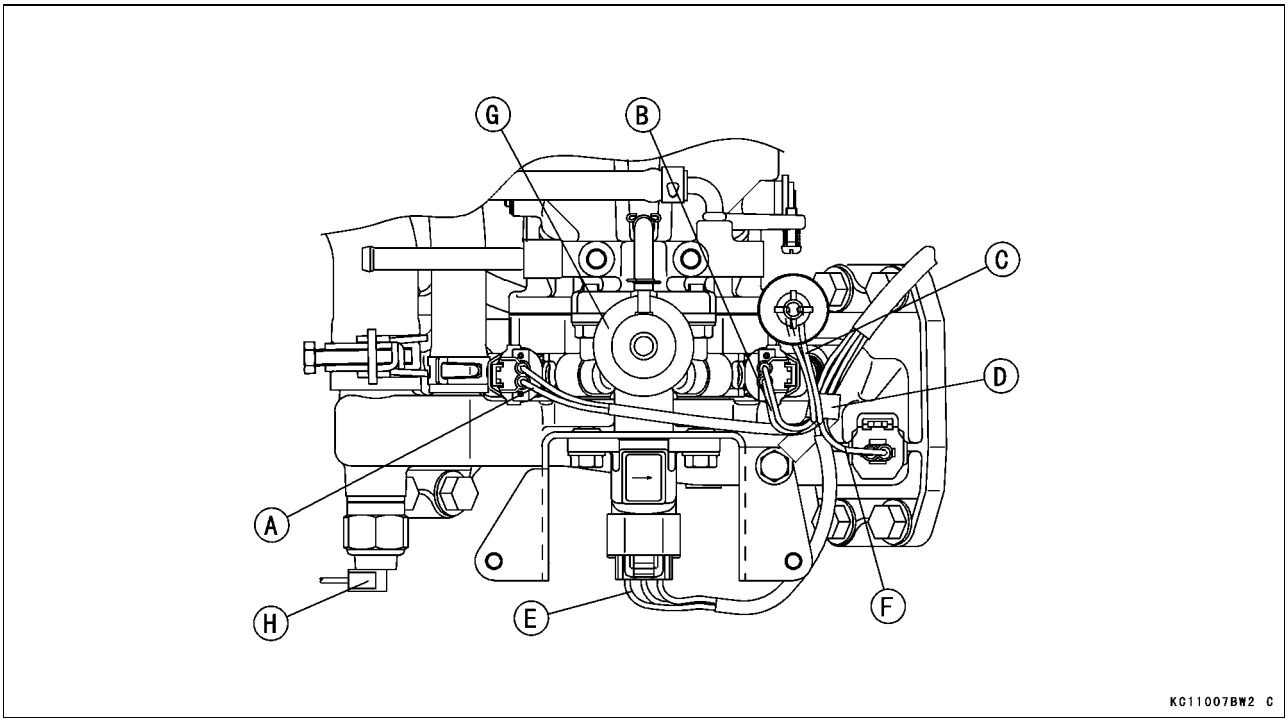
Digital Fuel Injection (DFI) System

Intake Manifold (DFI) Installation

- Before assembling the manifold, install the cylinder heads on each cylinder and tighten the head bolts (see Cylinder Head Installation).
- Place a new gaskets on each mating surface, and install the manifold.
- Tighten the manifold mounting bolts in sequence 3 N·m (0.31 kg·m, 26 in·lb) at a time until the torque on each bolt is 20 N·m (2.0 kg·m, 15 ft·lb).

Torque - Manifold (DFI) Mounting Bolts: 20 N·m (2.0 kg·m, 15 ft·lb)

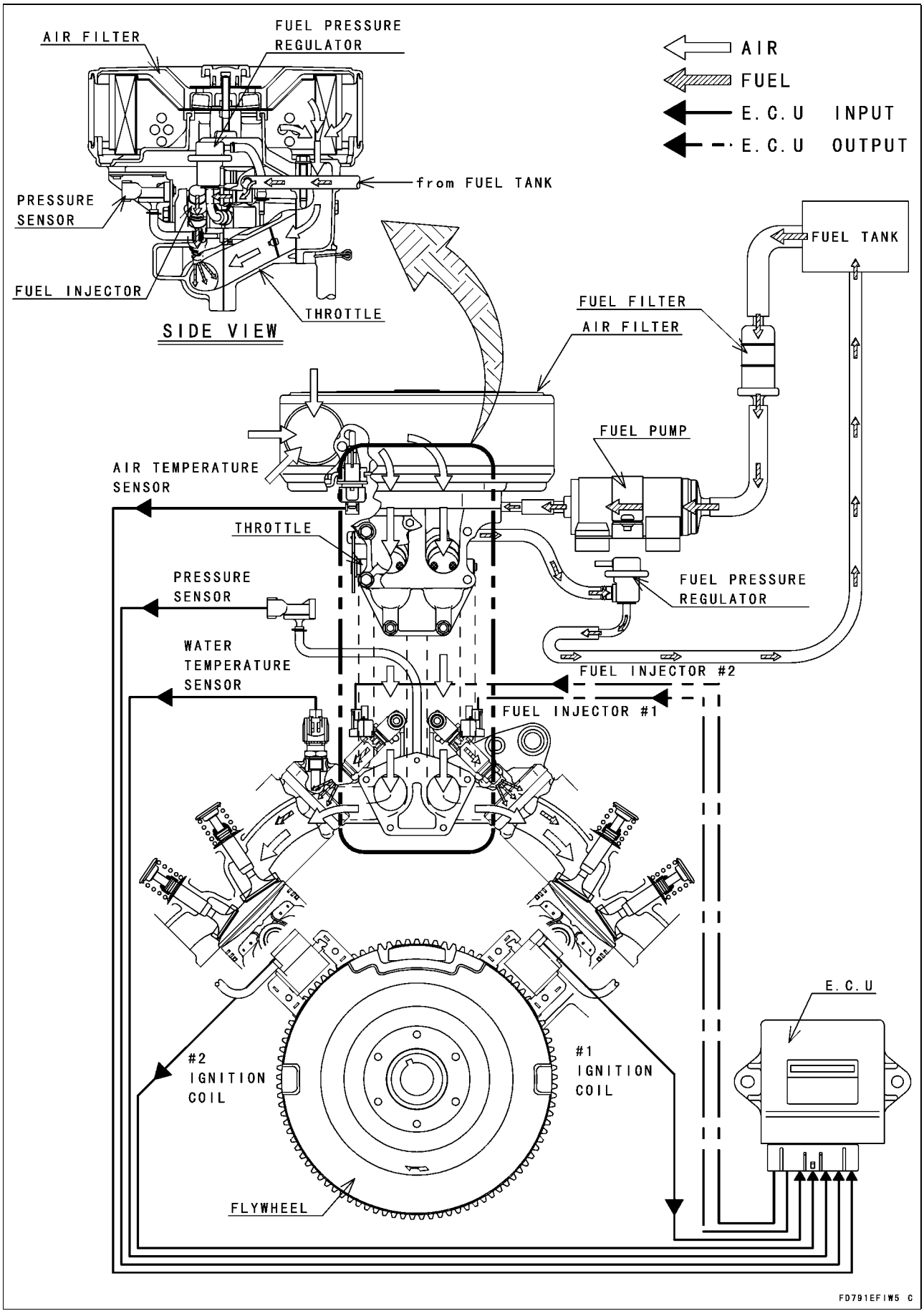
- Connect the connectors as shown.



[A] #1 Fuel injector (White/Green, White Lead)
[B] #2 Fuel Injector (White/Red, White Lead)
[C] Air Temperature Sensor (Green, White/Black Lead)
[D] Clamp/Tube
[E] Vacuum Pressure Sensor (White/Brown Lead)
[F] Water Temperature Sensor (Blue, White/Black Lead)
[G] Fuel Pressure Regulator
[H] Thermo Switch

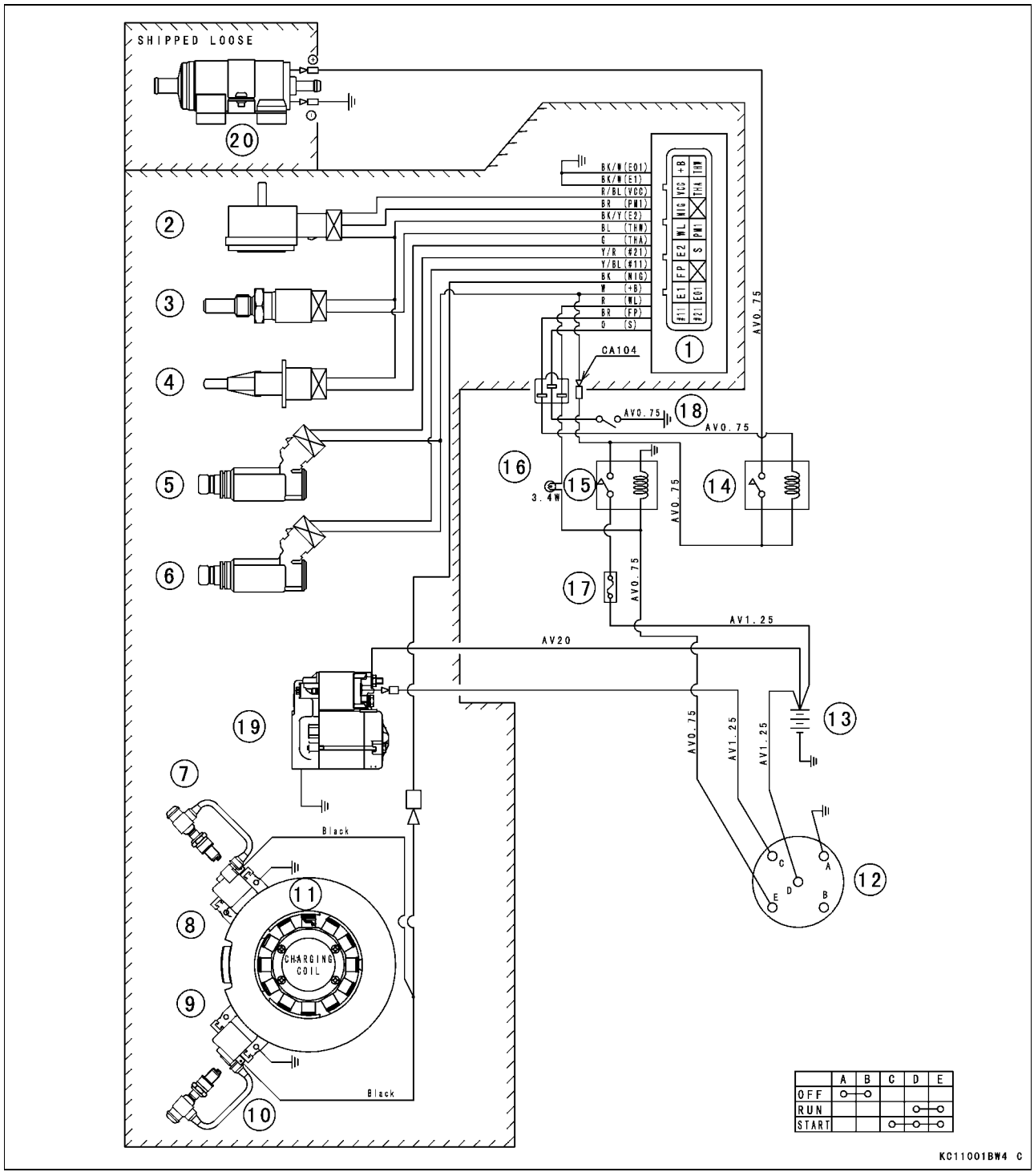
Digital Fuel Injection (DFI) System

DFI System



Digital Fuel Injection (DFI) System

DFI System Wiring Diagram



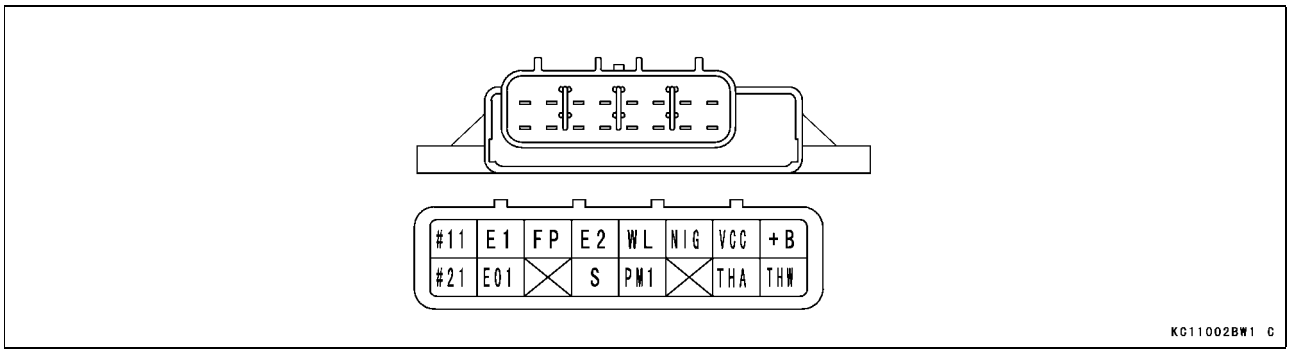
NOTE

○ *Portion surrounded by ⁄⁄⁄⁄⁄shows KHI procurement pars.*

1. ECU (Electronic Control Unit)
2. Vacuum Pressure Sensor
3. Water Temperature Sensor
4. Inlet Air Temperature Sensor
5. #2 Fuel Injector
6. #1 Fuel Injector
7. #1 Spark Plug
8. #1 Ignition Coil
9. #2. Ignition Coil
10. #2 Spark Plug
11. Flywheel
12. Ignition Switch
13. Battery (12 V)
14. Fuel Pump Relay
15. Main Relay
16. Diagnosis Lamp
17. Fuse (10 A)
18. Seat Switch
19. Electric Startor
20. Fuel Pump

Digital Fuel Injection (DFI) System

Terminal Numbers of ECU Connectors
(View from wire side)



#11. #1 Injector Signal
E1. ECU to Ground
FP. Fuel Pump Relay Signal
E2. Sensor System Circuit Ground
WL. Switch Displaying Diagnosis
NLG. Engine Speed Signal
VCC. Power Source to Sensor System
+ B. Power Supply to ECU
#21. #2 Injector Signal
E01. Power Source Circuit Ground
X. Not Used Terminal
S. Seat Switch Signal
PM1. Vacuum Pressure Sensor Signal
X. Not Used Terminal
THA. Air Temperature Sensor Signal
THW. Water Temperature Sensor Signal

Safety Instruction for DFI System Servicing

There are a number of important precautions that must be observed when servicing the electronic fuel injection system. Failure to observe these precautions can result in serious damage. Learn and observe all the rule listed below.

Electrical System

1. Do not disconnect the battery leads or any other electrical connections when the key switch is on, or while the engine is running. This is to prevent damageing the ECU.

NOTE

○ *Whenever electrical connections are to be disconnected, first turn off the key switch, disconnect the lead which connects the fuel injection system harness to the battery positive (+) post and then disconnect the required connection. There are two other leads which are connected to the battery positive post, but these leads can be left connected.*

2. Conversely, make sure that all electrical connections are firmly reconnected before staring the engine.
3. The fuel injection system is designed to be used with a 12 V battery as its power source.
4. Always disconnect the battery positive and negative leads from the terminals, and remove the battery from the equipment for charging. This is to prevent the control unit from being damaged by excessive peak voltage.
5. Avoid spraying water with any great pressure on the electric components, connectors, leads, and wiring harness of the electronic fuel injection system.
6. Keep the electronic fuel injection system wiring harness as for apart as possible from the high tension leads of the ignition system. This is to prevent the control unit from malfunctioning due to external electrical noise.
7. If a transceiver is installed on the equipment, make sure that the operation of the fuel injection system is not influenced by electric wave radiated from the antenna. Check operation of the system at the engine idles.

NOTE

○ *Locate the antenna as far as possible apart from the control unit. Interference from radio waves can be reduced by grounding the control unit box to the equipment.*

Fuel System

1. Do not operate the fuel pump dry. This is to prevent the pump from running without lubricant at the friction surfaces.
2. Blow the fuel system components with compressed air before removing the parts.
3. Any hose clamps on the high pressure fuel line must be replaced with new ones once they are loosened.

NOTE

○ *Install the hose clamps in the position, and securlly tighten the clamps. Check the fuel system for leaks.*

4. To prevent corrosion and deposits in the fuel system, do not add any antifreeze chemicals.

Air System

1. In order to maintain the correct fuel/air mixture ratio, there should be no air leaks in the system.

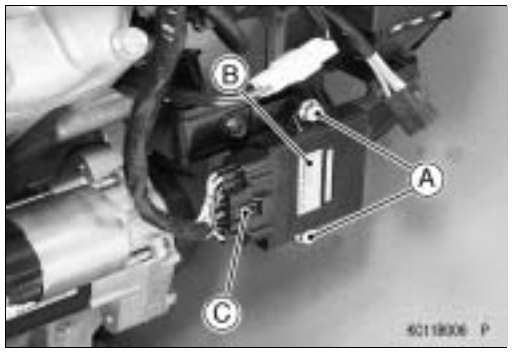
Electrical Control Unit (ECU)

CAUTION
Never drop the ECU, especially on a hard surface. Such a shock to the ECU can damage it.

ECU Removal

- Remove the bolts [A].
- Remove ECU [B].

★If necessary, disconnect the connector [C].



ECU Connector Inspection

- Visually inspect the terminals [A] of the ECU connectors.

★If the connector is clogged with mud or dust, blow it off with compressed air.

★Replace the main harness if the terminals of the harness connector are cracked, bent, or otherwise damaged.

★Replace the ECU if the terminals of the ECU connector are cracked, bent or otherwise damaged.

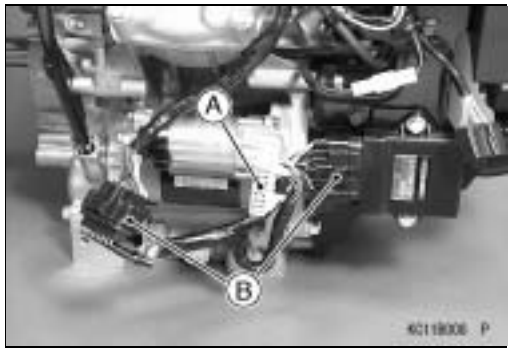
ECU Ground Inspection

- Disconnect the ECU connector.
- Connect the ECU adapter [A] between the connectors [B].

Special Tool - ECU Adapter: 57001–1500

NOTE

○ *Terminal number of harness adapter is the same as the ECU connector (see Terminal Number of ECU Adapter).*



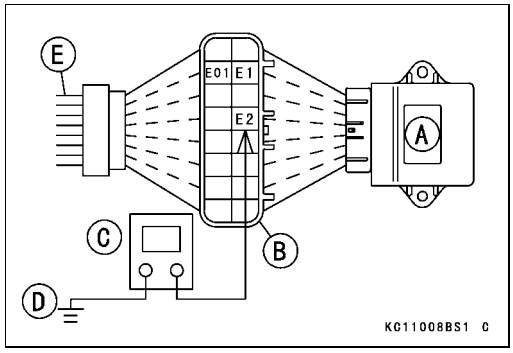
- Connect the handtester to the adapter and Engine ground (or Battery Terminal (-)).

E1 or E01 (BK/W) Terminal	←→	**Engine Ground: 0Ω**
E2 (BK/Y) Terminal	←→	**Engine Ground: 0Ω**

[A]: ECU
[B]: ECU Adapter
[C]: Hand Tester
[D]: Engine Gound
[E]: Harness

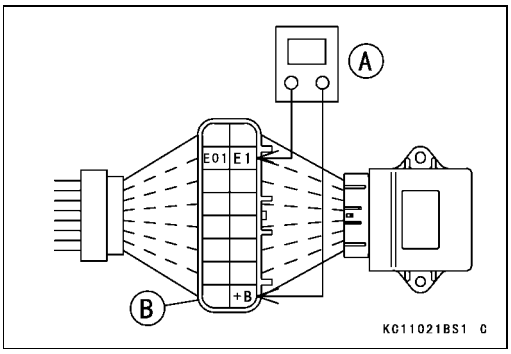
Special Tool - Hand Tester: 57001–1394

★If no continuity check the connector or the wire harness (Engine Ground Wire). Repair or replace as necessary.



Digital Fuel Injection (DFI) System

ECU Power Source Inspection



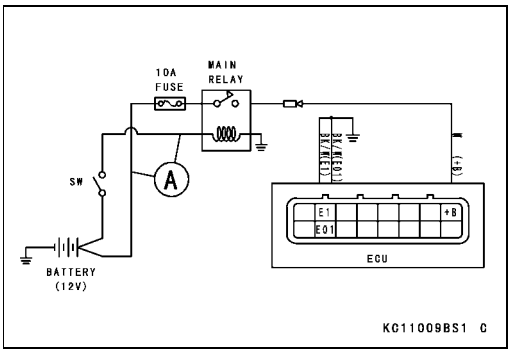
● Set the tester [A] to the DC25 V range and connect it to the adapter [B].

Special Tool - ECU Adapter: 57001–1500
Hand Tester: 57001–1394

Connections:
Tester Positive (+) → +B (W) Terminal
Tester Negative (-) → E1 or E01 (BK/W) Terminal

Ignition SW OFF Position:
ECU Power Source Voltage: 0 V

Ignition SW RUN Position:
ECU Power Source Voltage: Battery Voltage (12.5 V or more)



★If the tester does not read as specified, check the following:
Power Source Wiring [A]
Fuse (10 A)
Main Relay
★If the above checks prove in order, then the ECU is damaged and the ECU must be replaced.

Fuel Pump

Fuel Pump Operation Inspection

NOTE

○ *Be sure the battery is fully charged.*

● Turn the ignition switch RUN position and make sure that fuel pump operates (make light sounds) for 3 seconds, and then stops.
● Turn the ignition switch OFF.
★If the pump does not work as described above, inspect the operating voltage.

Operating Voltage Inspection

NOTE

○ *Be sure the battery is fully charged.*

● Turn the ignition switch OFF.
● Connect the hand tester (25 V DC) to the fuel pump connectors.

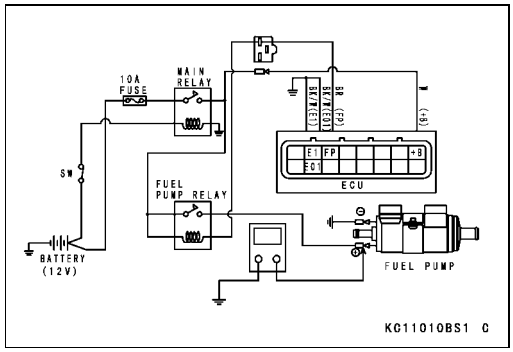
Special Tool - Hand Tester: 57001–1394

○ Measure the operating voltage with the engine stopped, and with the connector joined.
● Turn the ignition switch RUN position.
○ The tester needle should indicate battery voltage for 3 seconds, and then 0 V.

Pump Operating Voltage at Pump Connections to Pump Connectors
Tester (+) → Pump (+) Terminal
Tester (–) → Engine Ground

Operating Voltage at Pump Connector
Standard: Battery Voltage (12.5 V or more) for 3 seconds, and then 0 V.

★If the reading stays on battery voltage, and never shows 0 V. Check the ECU and fuel pump relay.
★If the voltage is in specification, but the pump doesn't work , replace the pump.
★If there is still no battery voltage, check the pump relay .



Fuel Flow Rate Inspection

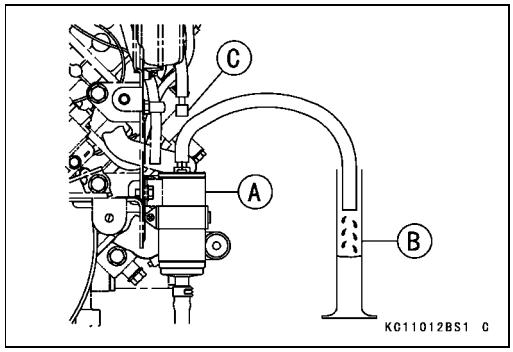
NOTE

○ *Be sure the battery is fully charged.*

⚠ WARNING

Gasoline is extremely flammable and can be explosive under certain conditions. Make sure the area is well-ventilated and free from any source of flame or sparks; this includes any appliance with a pilot light. Do not smoke. Turn the ignition switch OFF.
Be prepared for fuel spillage; any spilled fuel must be completely wiped up immediately.

● Prepare a measuring cylinder.
● Disconnect the fuel hose from the fuel pump out let pipe [A].
● Connect the appropriate hose and measuring cylinder [B] as shown.
● Quickly plug the fuel hose with a plug [C].



⚠ WARNING

Wipe off spilled out fuel immediately.
Be sure to hold the measuring cylinder vertical.

● Turn the ignition switch to the RUN position. The fuel pump should operate for 3 seconds, and then stop.
○ Measure the fuel flow rate so that the appropriate hose filled with fuel.

Amount of Fuel Flow
Standard: 120 mL or more for 3 seconds

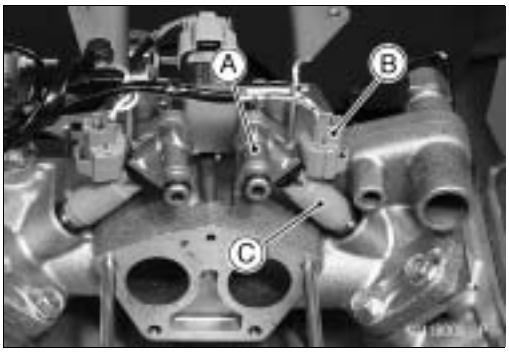
★If the fuel flow is much less than the specified, check the following:
Fuel Pump
Fuel Filter
Fuel Tank
● After inspection, connect the fuel hoses. (see Fuel Tank Installation).
● Start the engine and check for fuel leakage.

Digital Fuel Injection (DFI) System

Fuel Injectors (#1, #2)

CAUTION
Never drop the injector, especially on a hard surface. Such a shock to the injector can damage it.

Fuel Injector Removal

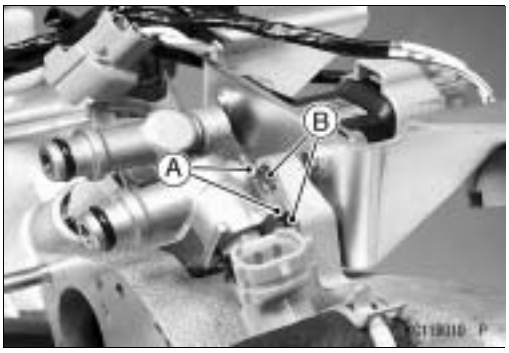


- Turn the ignition switch OFF.
- Remove:
  Air Cleaner and Related Parts (see Air Cleaner Removal)
  Radiator (see Radiator Removal)
  Cooling Fan and Fan Belt (see Cooling Fan and Fan Belt Removal)
  Throttle Body Assy (see Throttle Body Assy Removal)
  Injector Cap [A]
- Disconnect the injector connector [B].
- Pull out the fuel injector [C] from the intake manifold.

NOTE

○ *Take care not to damage the injector inserts when they are pulled from the throttle body.*

Fuel Injector Installation



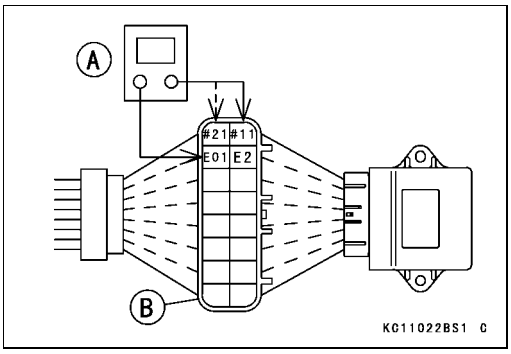
- Replace the seal and O-ring with a new one.
- Apply engine oil to the seal and O-ring.
- Install the injector to the intake manifold.
- Securely place the projections [A] of the injector cap into the holes [B] of the Intake.
- Connect the injector connector.

Power Source Voltage Inspection

- Refer:
  ECU Power Source Inspection in this chapter

★If the power source voltage is normal, check the injector out put voltage at injector.

Output Voltage Inspection



- Measure the output voltage at the injector connector in the same way as power source voltage inspection. Turn the ignition S.W RUN position, but do not start the engine.

Injector Output Voltage at Injector
Connections to injector #1
Tester Positive (+) → #11 (Y/BL) Terminal
Tester Negative (–) → E1 or E01 (BK/W) Terminal

Connections to injector #2
Tester Positive (+) → #21 (W/R) Terminal
Tester Negative (–) → E1 or E01 (BK/W) Terminal

Output Voltage at Injector Connector
Standard: Battery Voltage (12.5 V or more)

Special Tool - ECU Adapter [A]: 57001–1500
Hand Tester [B]: 57001–1394

★If the output voltage is normal, check the wiring for continuity. If the wiring is good, perform “Audible Inspection” for confirmation.

★If the output voltage is out of the standard, perform “Audible Inspection” for confirmation.

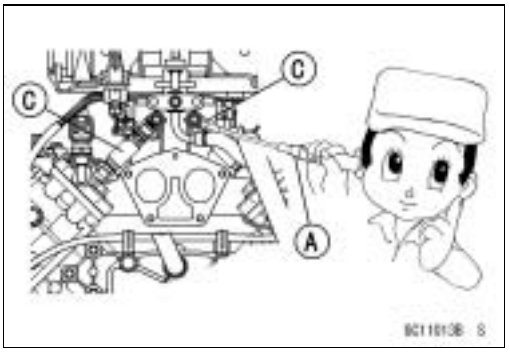
Audible Inspection

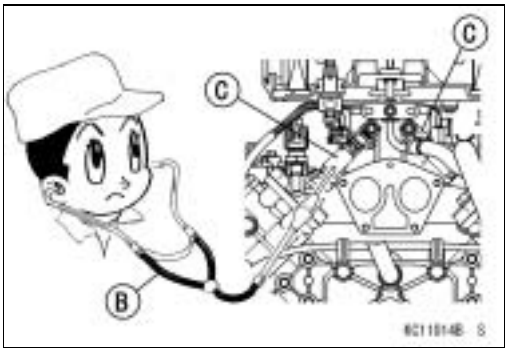
- Start the engine.
- Apply the tip of a screwdriver [A] to the injector [C]. Put the grip end onto your ear, and listen whether the injector is clicking or not.
- A sound scope [B] can also be used.
- Do the same for the other injector.

★If all the injectors click at a regular intervals, the injectors are good.

○ The click interval becomes shorter as the engine speed rises.

★If either injector doesn't click, perform the "Injector Signal Test" for injector operation.



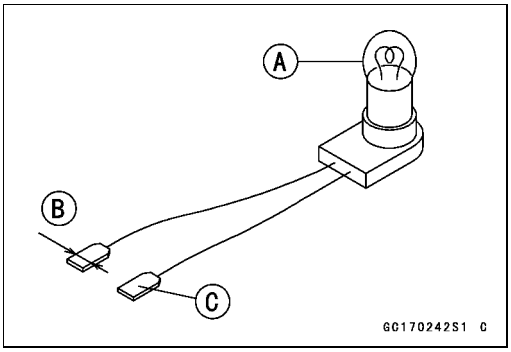


Injector Signal Test

- Prepare two test light sets with male terminals as shown.
  Rating of Bulb [A]: 12 V × 3 ∼ 3.4 W
  Terminal Width [B]: 1.8 mm
  Terminal Thickness [C]: 0.8 mm

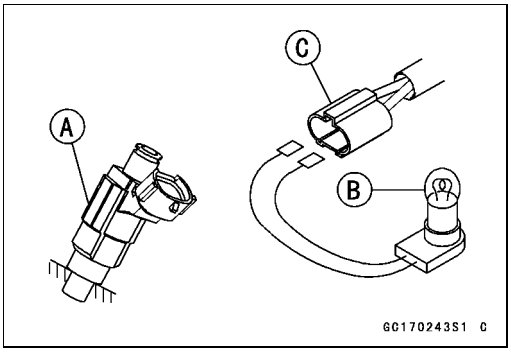
CAUTION

Do not use larger terminals than specified above. A larger terminal could damage the injector main harness connector (female), leading to harness repair or replacement.
Be sure to connect bulbs in series. The bulb works as a current limiter to protect the solenoid in the injector from excessive current.



- Remove connectors for injector [A].
- Connect each test light set [B] to the injector harness connector [C].
- Turn the ignition switch ON.
- While cranking the engine with the starter motor, watch the test lights.

★If the test lights flicker at regular intervals, the injector circuit in the ECU, and the wiring are good. Perform the "Injector Resistance Inspection".



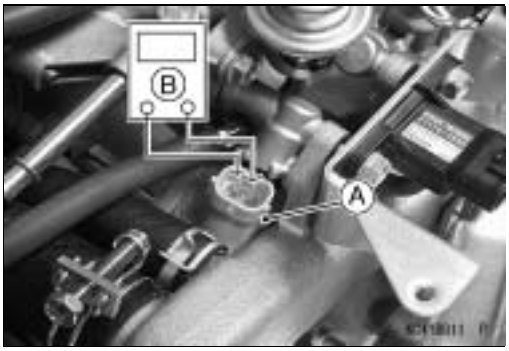
○ Injector signals can be also confirmed by connecting the hand tester (× 10 V AC) instead of the test light set to the injector harness (female) connector. Crank the engine with the starter motor, and check to see if the hand oscillates at regular intervals.

Special Tool - Hand Tester: 57001–1394

★If the test light doesn't flicker (or the test hand does not oscillate), check the wiring and connectors again. If the wiring is good, replace the ECU.

Digital Fuel Injection (DFI) System

Injector Resistance Inspection



- Disconnect the connector from the injector [A] (see Injector Removal).
- Measure the injector resistance with hand tester [B].

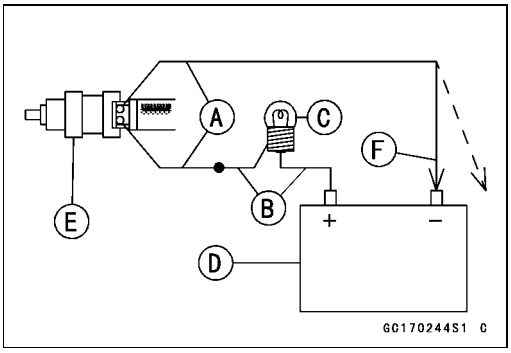
Injector Resistance
Connections to Injector

Tester (+)	Tester (–)
#1: W ←→	Y/BL Terminal
#2: W ←→	Y/R Terminal

Standard: 12.5 Ω

★If the reading is out of the range, perform the “Injector Unit Test”.
★If the reading is normal, perform the “Injector Unit Test” for comfirmaion.

Injector Unit Test



- Use two wires [A] and the same test light set [B] as in “Injector Signal Test”
  Rating of Bulb [C]: 12 V × (3 ∼ 3.4) W
  12 V Battery [D]

CAUTION

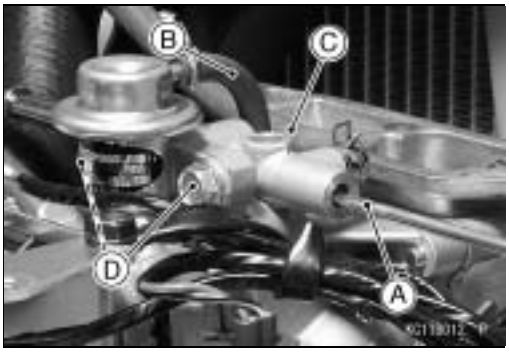
Be sure to connect the bulb in series. The bulb works as a current limiter to protect the solenoid in the injector from excessive current.

- Connect the test light set to the injector [E] as shown.
- Open and connect [F] the end of the wire to the battery (–) terminal repeatedly. The injector should click.

★If the injector does not click, replace the injector.
★if the injector clicks, check the wiring again. If the wiring is good, replace the ECU.

Fuel Pressure Regulator

Fuel pressure Regulator Removal



- Loosen the fuel pressure relief screw [A] to relieve the high pressure in the return fuel hose, then tighten it.
- Remove:
  Air Cleaner (see Air Cleaner Body Removal)
  Vacuum Hose [B]
  Fuel Return Hose [C]
  Bolts [D]
- Carefully remove the regulator.

Fuel Pressure Regulator Installation

- Check the vacuum tube, fuel hose and O-ring for brittleness, cracks, diformation or damaged, and replace, if necessary.
- Apply engine oil to the O-ring.
- Install:
  Fuel Pressure Regulator
  Vacuum Hose and Clamp
  Fuel Return Hose and Clamp
- Tighten the Bolts.

Fuel Pressure Regulator Inspection

NOTE

○ *Be sure the battery is fully charged.*

- Loosen the fuel pressure relief screw to relieve the high pressure in the return fuel hose, Then tighten it.
- Disconnect the fuel hose fitting from the throttle body assy.
- Install the prepare pressure gauge [A] between the fuel hose and throttle body assy.
- Tighten the hose clamp in the correct position.

⚠WARNING

Be prepared for fuel spillage; any spilled fuel must be completely wiped up immediately.
Do not try to start the engine with the fuel hoses disconnected.

- Start the engine, and set the high idle speed.

High Idle Speed: 3600 rpm

- Measure the fuel pressure.

Fuel Pressure
Standard: 172 ∼ 182 kPa (1.75 ∼ 1.85 kg/cm^2, 24.9 ∼ 26.4 psi)

★If the fuel pressure is higher than the specified, check the following:
Fuel Return Hose for sharp bends, kinking, or clogging
Vacuum Hose of the Pressure Regulator for air leaks
★If they prove good, replace the pressure regulator.
★If the fuel pressure is much lower than specified, check the following:
Fuel Line Leakage
Fuel Filter and Fuel Pump
★If inspection above checks out good, replace the pressure regulator or fuel pump (see fluid flow rate inspection).
- Remove pressure gauge.
- Connect the fuel hose to the throttle body assy and clamp it.

Self-Diagnosis

Self-Diagnosis Outline

When an abnormality in the ECU system occurs, the Self-Diagnosis light flash to alert the user, and initiates fail-safe function.

Self-Diagnosis Procedures

- Turn on the ignition switch. The Self-Diagnosis light should flash when the switch is turned on.
- Turn off ignition switch.

★If the bulb does not flash as described above, check the bulb and wiring of the diagnosis light in the chassis side harness.

- Turn on the ignition switch again, the Self-Diagnosis light should flash.
- After about two second, count the number of blinks of the Self-Diagnosis light to read the fault code.

NOTE

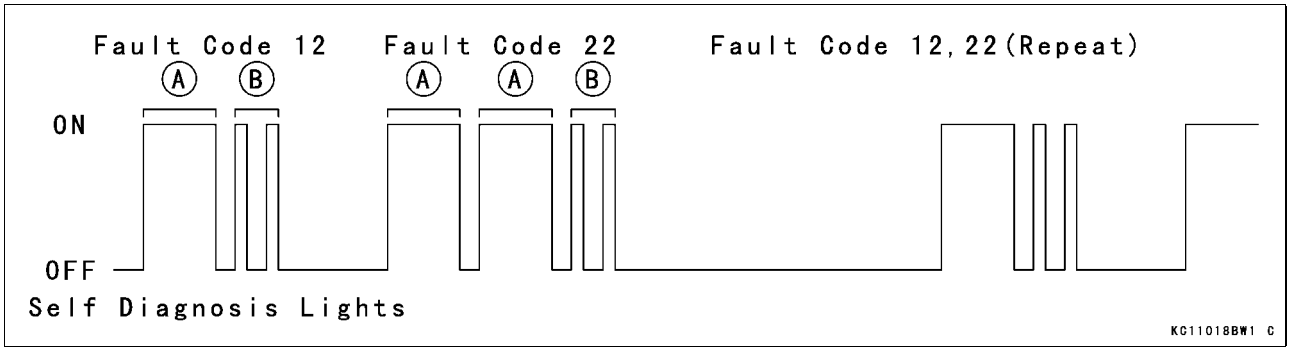
○ *Use a fully charged battery when conducting self diagnosis. otherwise, the Self-Diagnosis light will blink very slowly or not at all.*

Digital Fuel Injection (DFI) System

How to Read Fault Codes

○ Fault codes are shown by a series of long and short blinks of the Self Diagnosis light as shown below.
○ Read 10th digit and unit digit as the Self Diagnosis light blinks.
○ When there are a number of problems, all the fault codes can be stored and the display will begin starting from the lowest number fault code in the numerical order. Then after completing all codes, the display is repeated until the ignition switch is turned OFF.
○ If there is no problem, no code is shown.
○ For example, if the problems 12 and 22 occur, the fault codes 12 and 22 are shown as follows.

(12 → 22) → (12 →22) → · · · · · ·(repeated)



[A]: 10th digit
[B]: Unit digit

Fault Code	Self-Diagnoss Light	Problems (1)
12	ON / OFF	Inlet air temperature sensor malfunction, wiring open or short
13		Water temperature sensor malfunction, wiring open or short
21		Vacuum pressure sensor malfunction, wiring open or short
22		Atmospheric pressure measurement error (engine stop, then turn on the ignition switch slowly)

Footnotes:

1. The ECU may be involved in these problems. If all the parts and circuits check out, check the ECU for ground and power supply. If the ground and power supply are good, replace the ECU.

Inlet Air Temperature Sensor (Fault Code 12)

CAUTION
Never drop the sensor, especially on a hard surface. Such a chock to the sensor can damage it.

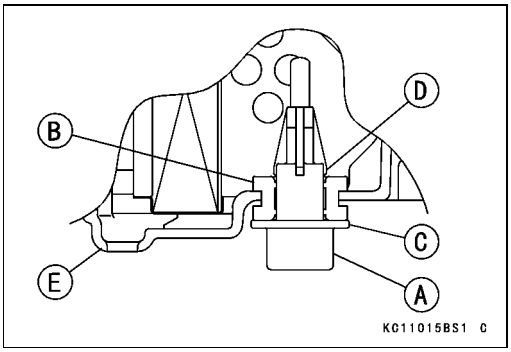
Removal

● Remove the air cleaner upper case and elements.
● Disconnect the connector [A] from the inlet air temperature sensor.
● Support the tapered portion with suitable tool and remove the inlet air temperature sensor.

Installation

● Push the sensor [A] into the grommet [B] until the flange of sensor [C] touches the grommet, and locks knob [D].

[E]: Air Cleaner Body



Output Voltage Inspection

NOTE

○ *Be sure the battery is fully charged.*

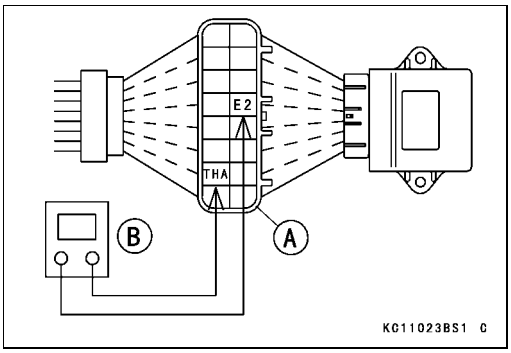
● Turn the ignition switch OFF.
● Disconnect the ECU connector.
● Connect the adapter [A] between the connectors.

Special Tool - ECU Adapter: 57001–1500

● Set the tester [B] to the DC 10 V range and connect it to the adapter.

Special Tool - Hand Tester: 57001–1394

Connections:
Tester Positive (+) → THA (G) Lead
Tester Negative (–) → E2 (BK/Y) Lead



● Turn the ignition switch to the RUN position.

Output Voltage
Standard: about 2.26 ∼ 2.50 V at inlet air temperature 20°C (68°F)

NOTE

○ *The output voltage changes according to the inlet air temperature.*

● Turn the ignition switch OFF.

★If the output voltage is out of the specified, check the ECU's ground, and power supply (see ECU section in this chapter). If the ground and power supply are good, replace the ECU.
★If the output voltage is far out of the specified, check the wiring.
★If the wiring is good, check the sensor resistance.

Sensor Resistance inspection

- Remove the inlet air temperature sensor (see this section).
- Suspend the sensor [A] in a container of machine oil so that the heat-sensitive portion and threaded portion are submerged.
- Suspend a thermometer [B] with the heat-sensitive portion [C] located in almost the same depth with the sensor.

NOTE

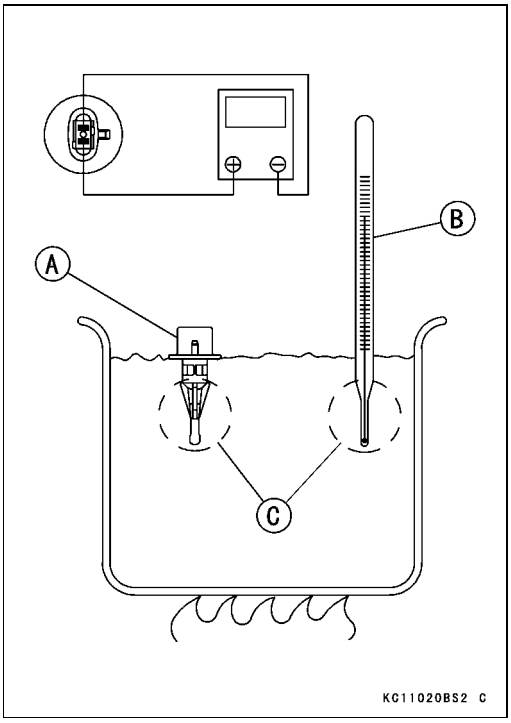
○ *The sensor and thermometer must not touch the container side or bottom.*

- Place the container over a source of heat and gradually raise the temperature of the oil while stirring the oil gently for even temperature.
- Using a digital meter, measure the internal resistance of the sensor across the terminals at the temperatures shown in the table.

Inlet Air Temperature Sensor Resistance

Standard: 5.29 ∼ 5.47 kΩ at 0°C (32°F)
2.21 ∼ 2.69 kΩ at 20°C (68°F)
0.133 ∼ 0.163 kΩ at 80°C (176°F)

★If the measurement is outside the specified range, replace the sensor.
★If the measurement is within the specified range, replace the ECU.



Water Temperature Sensor (Fault Code 13)

Removal/Installation

CAUTION

Never drop the sensor, especially on a hard surface. Such a shock to the sensor can damage it.

- Disconnect the sensor connector [A], and unscrew the water temperature sensor [B].
- Install new water temp sensor.

Silicone Sealant (Kawasaki Bond: 56019–120)

- Threads of Water Temperature Sensor

Torque - Water Temperature Sensor: 20 N·m (2.0 kg·m, 14 ft·lb)

- Fill the engine with coolant and bleed the air from the cooling system (see Coolant Filling in the Cooling System chapter).

Output Voltage Inspection

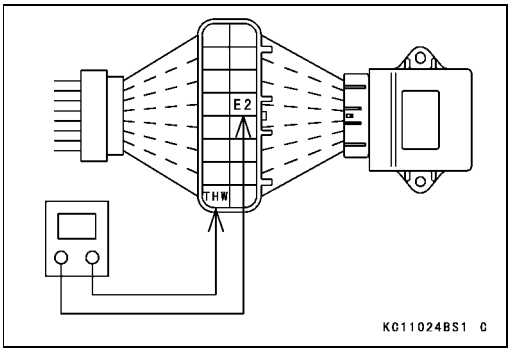
NOTE

○ *Be sure the battery is fully charged.*

- Measure the output voltage at the water temperature sensor connector the same way as the inlet air temperature sensor output voltage inspection. Note the following.

Connections:
Tester Positive (+) → THW (BL) Lead
Tester Negative (–) → E2 (BK/Y) Lead

Output Voltage
Standard: about 2.26 ∼ 2.50 V at 20°C



NOTE

○ *The output voltage changes according to the coolant temperature in the engine.*

★If the output voltage is out of the specified range, check the ECU's ground and power supply (see his chapter). If the ground and power supply are good, replace the ECU.

★If the output voltage is far out side the specified range, check the wiring.

★If the wiring is good, check the water temperature sensor resistance.

Water Temperature Sensor Inspection

● Remove the water temperature sensor.

● Suspend the sensor [A] in a container of coolant so that the temperature-sensing projection and threaded portion are submerged.

● Suspended an accurate thermometer [B] in the coolant.

NOTE

○ *The sensor and thermometer must not touch the container side or bottom.*

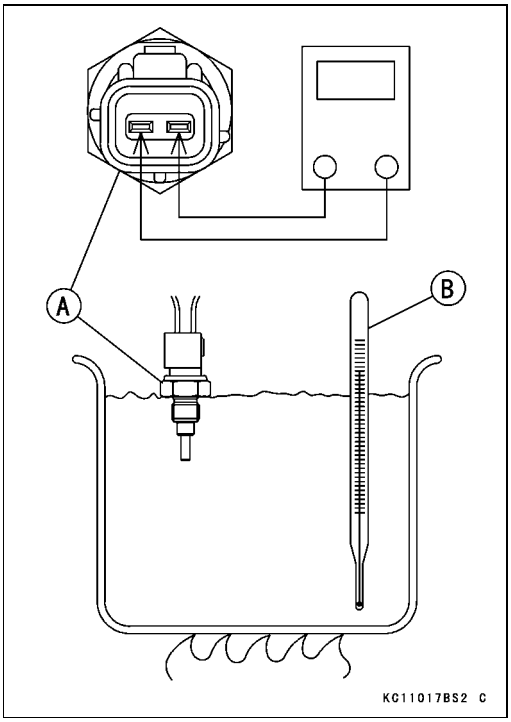
● Place the container over a source of heat and gradually raise the temperature of the coolant while stirring the coolant gently.

● Using the hand tester, measure the internal resistance of the sensor.

○ The sensor sends electric signals to the ECU (Electronic Control Unit).

○ Measure the resistance across the terminals and the body (for the gauge) at the temperatures shown in the table below.

★If the hand tester does not show the specified values, replace the sensor.



Water Temperature Sensor Resistance

Temperature	Resistance (kΩ)	
	Standard	Service Limit
20°C (68°F)	2.21 ∼ 2.69	1.96 ∼ 2.94
80°C (176°F)	0.290 ∼ 0.354	0.258 ∼ 0.386
110°C (230°F)	0.133 ∼ 0.163	0.118 ∼ 0.178

Vacuum Sensor (Fault Code 21)

CAUTION

Never drop the sensor, especially on a hard surface. Such a shock to the part can damage it.

Removal/Installation

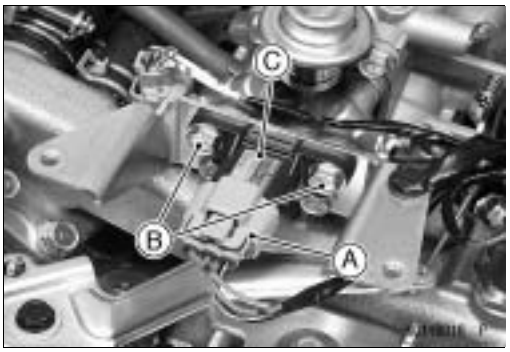
● Remove the air cleaner.

● Disconnect the vacuum sensor connector [A].

● Remove:
Vacuum Hose
Bolts [B]

● Remove the vacuum sensor [C].

● Make sure the vacuum hose does not get pinched or kinked.



Input Voltage Inspection

NOTE

○ *Be sure the battery is fully charged.*

● Turn the ignition switch OFF.

● Disconnect the ECU connector.

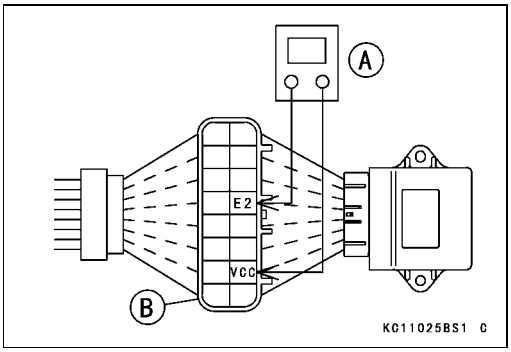
● Connect the adapter between the connectors.

Special Tool - ECU Adapter: 57001–1400

● Set the tester [A] to the DC 10 V range, and connect it to the adapter [B].

Special Tool - Hand Tester: 57001–1394

Connections:
Tester Positive (+) → VCC (BR/BL) Lead
Tester Negative (–) → E2 (BK/Y) Lead



● Turn the ignition switch to the RUN position.
● Read the voltage of the tester.

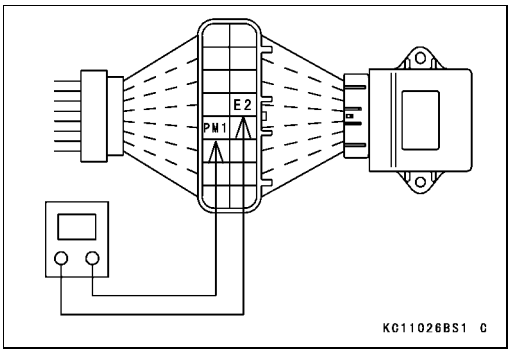
Input Voltage
Standard: 4.75 ∼ 5.25 V DC

★If the reading is less than the standard range, check the ECU's ground, and power supply (see this chapter). If the ground and power supply are good, replace the ECU.
★If the reading is good, the input voltage is normal, check the output voltage.

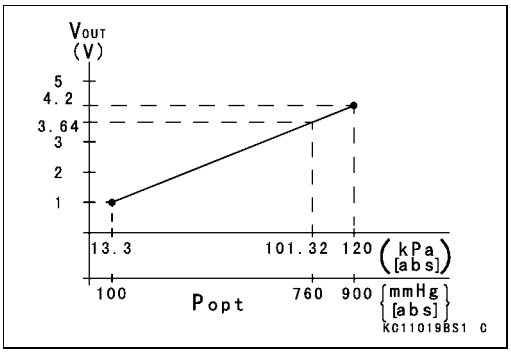
Output Voltage Inspection

● Measure the output voltage in the same way as the input voltage inspection. Note the following.

Vacuum Sensor Output Voltage
Connections
Tester Positive (+) → PM1 (BR) Lead
Tester Negative (–) → E2 (BK/Y) Lead



Output Voltage
Usable Range: 3.26 ∼ 4.04 V DC at the standard atmospheric Puressure (101.32 kPs, 76 cmHg abs.)



NOTE

○ *Depending on the local atmospheric pressure, the output voltage should be changed according to the chart.*

[Vout]: Output Voltage
[Popt]: Local Atmospheric Pressure

★if the output voltage is normal, check the wiring for continuity.
★If the output voltage is outside the usable range, replace the sensor.
● Turn the ignition switch OFF.
● Remove the ECU adapter.

Cooling System

Table of Contents

Exploded View....3-2
Specifications....3-4
Cooling System....3-5
Coolant....3-6
- Coolant Deterioration....3-6
- Coolant level Inspection....3-6
- Coolant Draining....3-6
- Coolant Filling....3-7
- Air Bleeding....3-7
- Visual Leak Inspection....3-8
- Cooling System Pressure Testing....3-8
- Flushing....3-9

Water Pump....3-10
- Water Pump Removal....3-10
- Water Pump Installation....3-10
- Water Pump Disassembly....3-11
- Internal Parts — Mechanical Seal....3-11
- Pumps Parts Inspection....3-12
- Water Pump Assembly....3-12

Radiator....3-13
- Radiator Removal....3-13
- Radiator Installation....3-13
- Radiator Inspection....3-13
- Radiator Cap Inspection....3-14
- Radiator Hose Inspection....3-14
- Radiator Hose Installation Notes....3-15

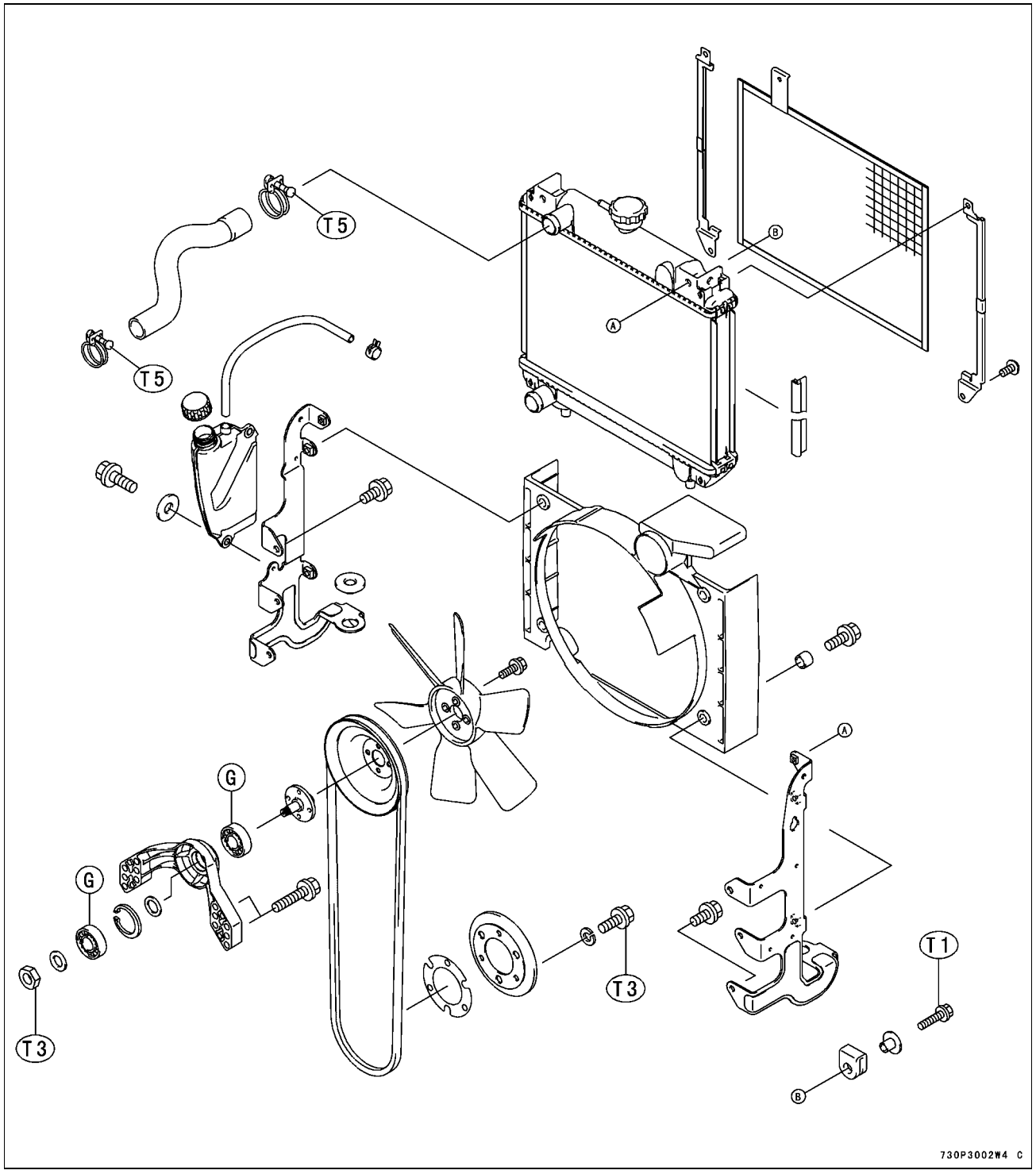
Cooling Fan, Fan Belt....3-16
- Belt Tension Check....3-16
- Belt Replacement....3-16
- Cooling Fan, Fan Belt Removal....3-17
- Cooling Fan, Fan Belt Installation....3-18
- Cooling Fan, Fan Belt Inspection....3-18
- Fan Bearing Removal....3-18
- Fan Bearing Installation....3-18

Thermostat....3-19
- Thermostat Removal and Installation....3-19
- Thermostat Inspection....3-19

Thermo Switch....3-20
- Thermo Switch Removal and Installation....3-20
- Thermo Switch Inspection....3-20

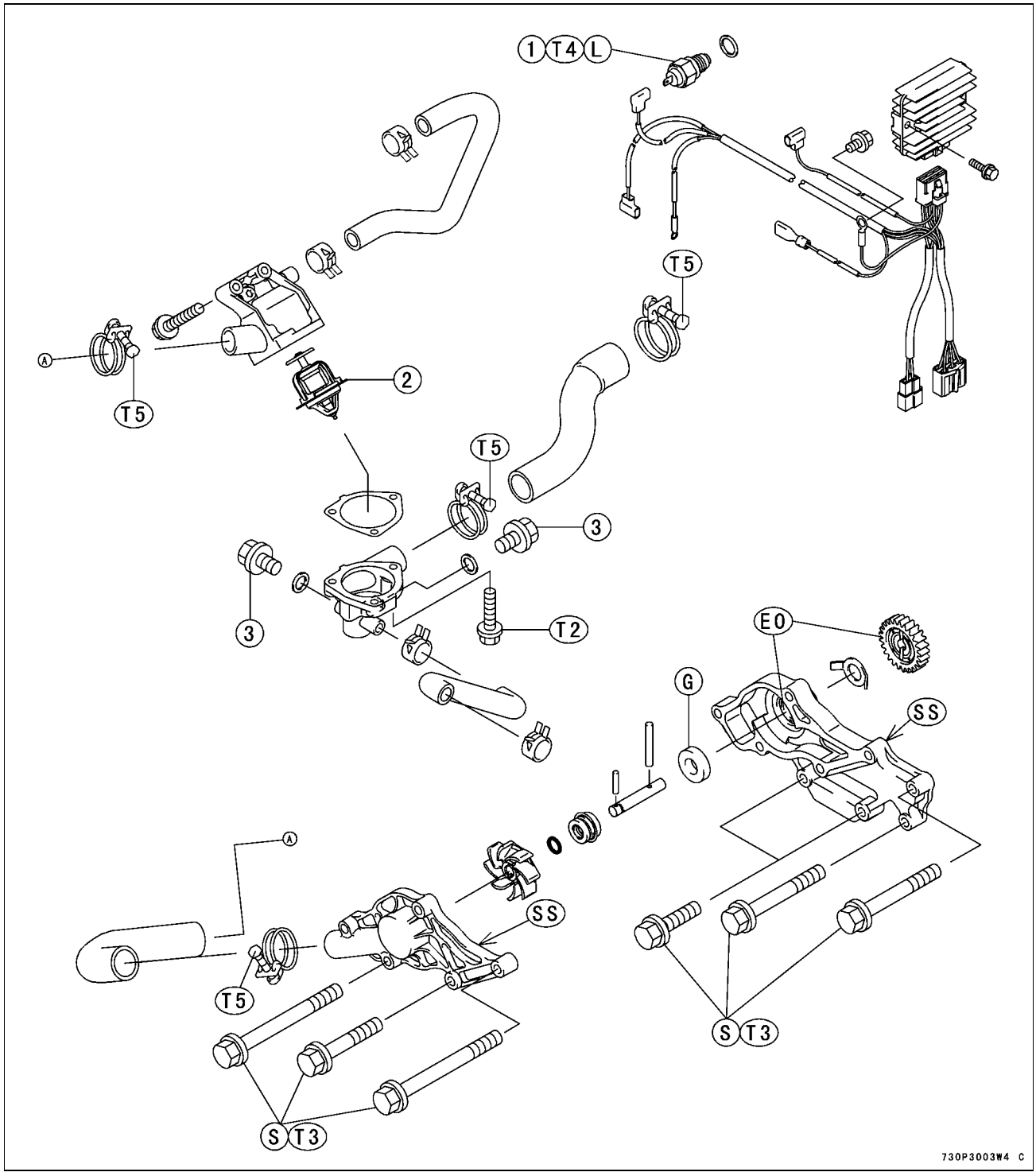
3-2 COOLING SYSTEM

Exploded View



G: Apply grease.
T1: 6 N·m (0.6 kg·m, 52 in·lb)
T3: 20 N·m (2.0 kg·m, 15 ft·lb)
T5: 1.2 N·m (0.12 kg·m, 11 in·lb)

Exploded View



1. Thermo Switch
2. Thermostat
3. Drain Plug

EO: Apply engine oil.
G: Apply grease.
L: Apply a non-permanent locking agent.
S: Follow the specific tightening sequence.
SS: Apply silicone sealant.
T2: 10 N·m (1.0 kg·m, 87 in·lb)
T3: 20 N·m (2.0 kg·m, 15 ft·lb)
T4: 27 N·m (2.8 kg·m, 20 ft·lb)
T5: 1.2 N·m (0.12 kg·m, 11 in·lb)

3-4 COOLING SYSTEM

Specifications

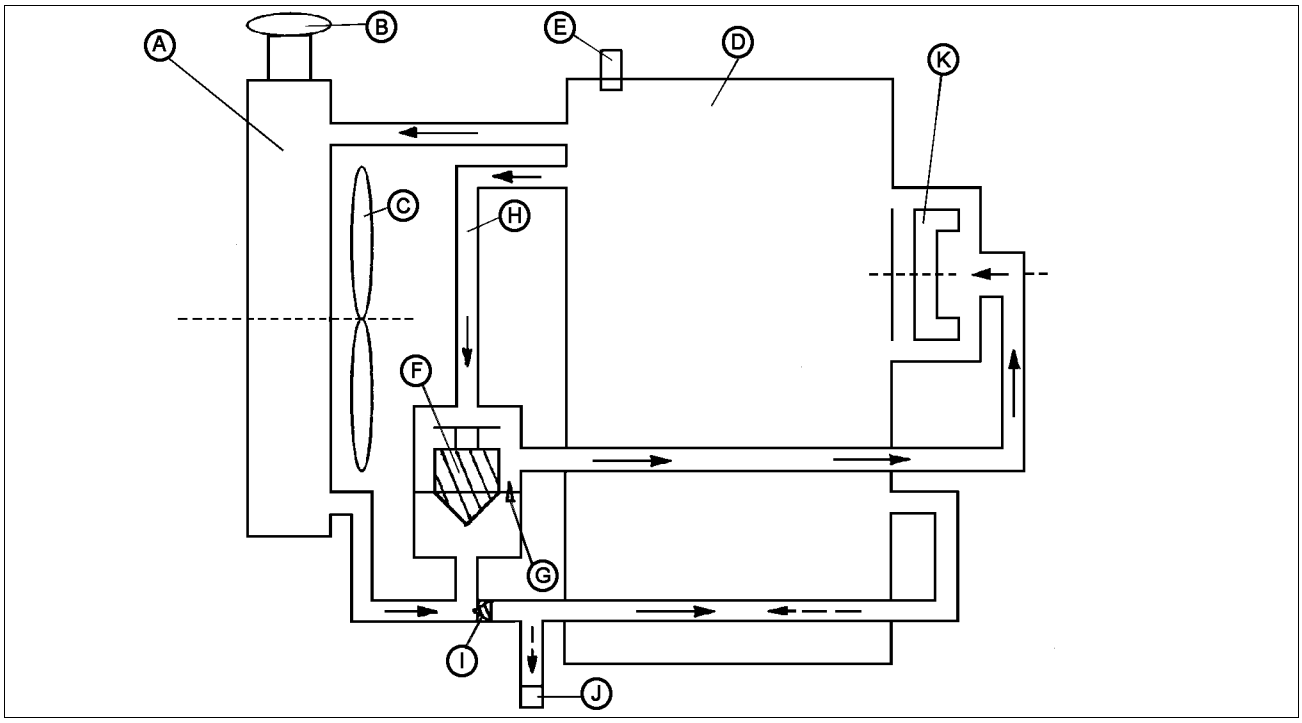
Item	Standard
*Coolant:	
Type	Permanent type of antifreeze for aluminum engine and radiator
Color	Green
Mixed ratio	50% solution of ethylene glycol
Freezing point	-35°C (-31°F)
Total amount	2.7 L (2.9 US qt)
Radiator Cap Relief Pressure:	
Pressure valve (positive)	78 to 98 kPa (0.80 to 1.00 kg/cm^2, 11.3 to 14.2 psi)
Vacuum valve (negative)	4.90 kPa (0.050 kg/cm^2, 0.71 psi)
Thermostat:	
Valve openning temperature	80.5 to 83.5°C (177 to 182°F)
Valve full openning lift	not less than 8 mm (0.31 in) at 95°C (203°F)
Thermo Switch:	
Detect Temerature	108 to 114°C (226 to 237°F)

*A permanent type of antifreeze is not installed in the cooling system when shipped.

Cooling System

This engine is equipped with a highly efficient pressurized cooling system using a thermostat to maintain an optimum operating temperature. Coolant bypasses the closed thermostat when cold until operating temperature is attained, causing the engine to warm up more quickly. If the coolant temperature becomes too high, a thermo switch on the engine activates the coolant warning lamp to alert the operator or cooling problem.

[A] Radiator
[B] Radiator Cap
[C] Cooling Fan
[D] Engine Body
[E] Thermos Switch
[F] Thermostat
[G] Jiggle Valve
[H] Bypass Tube
[I] One Way Valve
[J] Drain Plug
[K] Water Pump (Impeller)



⚠ WARNING

Prior to disassembly of cooling system parts (radiator, pump, sensor, etc), wait until the coolant cools down, and then drain the coolant.

CAUTION

After assembling and filling the system with a coolant, purge any air from the system.

Coolant

Coolant Deterioration

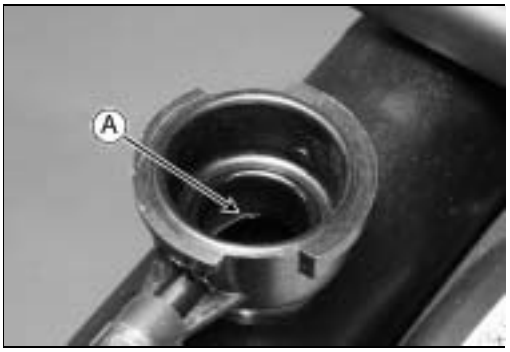
- Visually inspect the coolant in the radiator.
- ○ If whitish cotton-like wafts are observed, aluminum parts in the cooling system are corroded. If the coolant is brown, iron or steel parts are rusting. In either case, flush the cooling system.
- ○ If the coolant gives off an abnormal smell when changing, check for a cooling system leak. It may be caused by exhaust gas leaking in to the cooling system.

Coolant level Inspection

- Put the engine on a level surface.
- Remove the radiator cap turning it counterclockwise and check the coolant level in the radiator.

⚠ WARNING

Always allow the engine to cool before removing the radiator cap. Then remove the cap slowly and carefully to avoid a possible fast discharge of hot coolant which could cause severe burns.



- Coolant level must be maintained a level of the filler neck bottom [A].
- ★ If the amount of the coolant is insufficient, fill the radiator up to the bottom of the radiator filler neck [A] with the coolant, and install the cap turning it clockwise.

CAUTION

For refilling, add the specified mixture of coolant and soft water. Adding water alone dilutes the coolant and degrades its anticorrosion properties. The diluted coolant can attack the aluminum engine parts. In an emergency, soft water can be added. But the diluted coolant must be returned to the correct mixture ratio within a few days.
If coolant must be added often, there is probably leakage in the cooling system. Check the system for leaks (see Visual Leak Inspection, and Pressure Testing).

Coolant Draining

The coolant should be changed periodically to ensure long engine life.

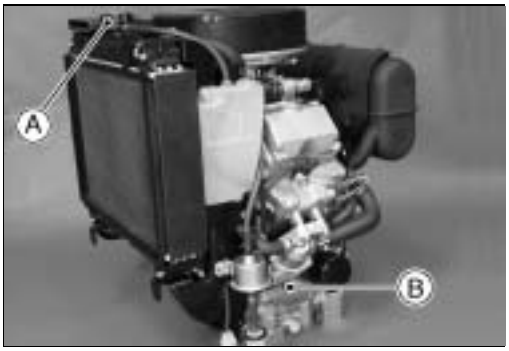
CAUTION

Use coolant containing corrosion inhibitors made specifically for aluminum engines and radiators in accordance with the instructions of the manufactures (see Coolant Filling Section).

Coolant

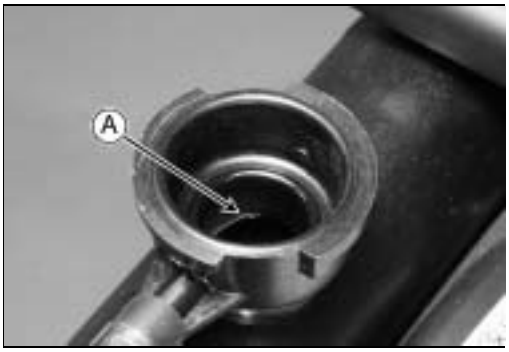
⚠ WARNING

To avoid burns do not remove the radiator cap or try to change the coolant when the engine is still hot. Wait until it cools down. Since coolant is harmful to the human body, do not use for drinking.



- Remove the radiator cap [A] as follows.
  - First turn the cap counterclockwise to the first stop and wait there for a few seconds.
  - Push down the cap, then turn the cap counterclockwise to the next stop.
  - Lift off the cap.
- Place a suitable container under the drain plug [B] (black head). Turn the drain plug counterclockwise to drain the coolant in the radiator and water jacket.
- Inspect the old coolant for color and smell (see Coolant Deterioration).

Coolant Filling



- Install the drain plug. Always replace the gaskets with a new ones, if they are damaged.
- Tighten the drain plug to the specification (see Exploded Views).
- Fill the radiator up to bottom of the radiator filler neck [A] with coolant, and install the cap turning it clockwise.

NOTE

- *Pour in the coolant slowly so that it can expel the air from the engine and radiator.*
- *To install the radiator cap, push down it and then turn the cap clockwise to the rest of the way.*

CAUTION

Soft or distilled water must be used with the antifreeze in the cooling system.
If hard water is used in the system, it causes scales accumulation in the water passages, and considerably reduces the efficiency of the cooling system.

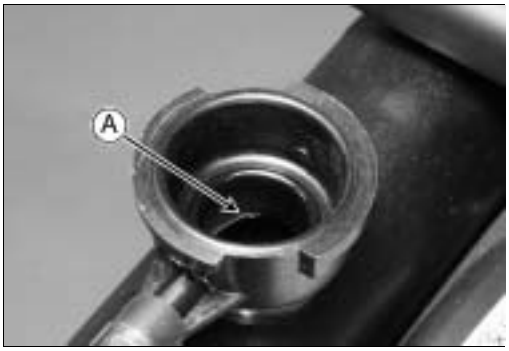
NOTE

- *Choose a suitable mixture ratio by referring to the coolant manufacturer's instructions.*

Original Coolant

Type:	**Permanent type antifreeze for aluminum engine and radiator**
Color:	**Green**
Mixed ratio:	**50% solution of ethylene glycol**
Freezing Point:	**-35°C (-31°F)**
Total amount:	**2.7 L (2.9 US qt)**

Air Bleeding



Before putting the engine into operation, any air trapped in the cooling system must be removed as follows.

- Remove the radiator cap.
- Fill the radiator up to the radiator filler neck with coolant.
- Check the cooling system for leaks.
- Install the radiator cap.
- Start the engine, warm it up thoroughly, and then stop it.
- Check the coolant level in the radiator after the engine cools down.
- ★ If the coolant level is low, add coolant up to the filler neck bottom [A].
- Install the cap.

3-8 COOLING SYSTEM

Coolant

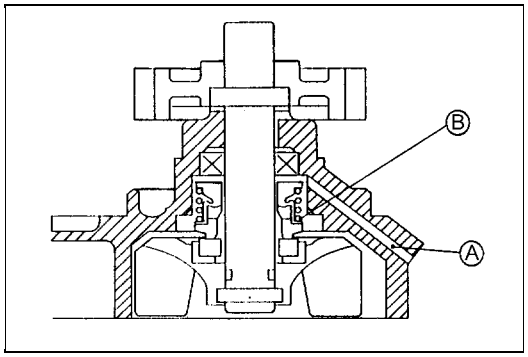
Visual Leak Inspection

Any time the system slowly loses water, inspect for leaks. Small leaks may appear only a rust, corrosion or stain due to evaporation. Watch for these trouble spots.

- Check the water pump housing drainage outlet passage [A] for coolant leaks.

★If the mechanical seal is damaged, the coolant leaks through the seal and drain through the passage. Replace the mechanical seal [B].

★If there are no apparent leaks, pressure test the system.



Cooling System Pressure Testing

Air pressure leakage tester can help locate external leaks but they cannot depended upon to locate small combustion leaks.

CAUTION

During pressure testing, do not exceed the pressure for which the system is designed. The maximum pressure is 102.7 kPa (1.05 kg/cm^2, 14.9 psi).

- Remove the radiator cap, and install a cooling system pressure tester [A] on the radiator filler neck.
- Wet the cap sealing surfaces with water or coolant to prevent pressure leaks.
- Build up pressure in the system carefully until the pressure reaches 60 kPa (0.61 kg/cm^2, 8.7 psi).
- Watch the pressure gauge for at least 6 seconds. If the pressure holds steady, the system is all right.
- Remove the pressure tester, replenish the coolant, and install the cap.

★If the pressure drops and no external source is found, check for internal leaks. Droplets in the engine oil indicate internal leakage. Check the cylinder head gaskets.

Coolant

Flushing

Over a period of time, the cooling system accumulates rust, scale, and lime in the water jacket and radiator. When this accumulation is suspected or observed, flush the cooling system. If this accumulations is not removed, it will clog up the water passage and considerably reduce the efficiency of the cooling system.

⚠ WARNING

Prior to disassembly of cooling system parts (radiator, pump, sensor, etc), wait until the coolant cools down, and then drain the coolant.

CAUTION

After assembling and filling the system with a coolant, purge any air from the system.

- Drain the cooling system.
- Fill the cooling system with fresh water mixed with a flushing compound.

CAUTION

Avoid the use of a flushing compound which is harmful to the aluminum engine and radiator. Carefully follow the instructions supplied by the manufacturer of the cleaning product.

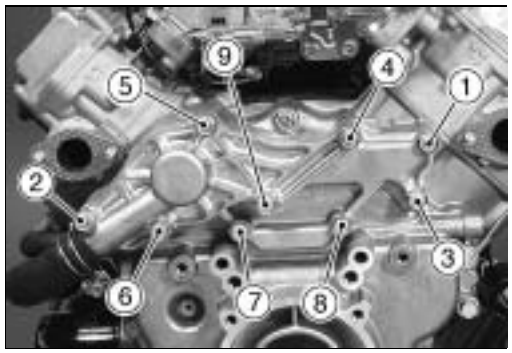
- Warm up the engine, and run it at normal operating temperature for about ten minutes.
- Stop the engine, and drain the cooling system.
- Fill the system with fresh water.
- Warm up the engine and drain the system.
- Repeat the previous two steps once more.
- Fill the system with a permanent type coolant, and bleed the air from the system.

Water Pump

Water Pump Removal

- Remove:
  Muffler (see Muffler Assembly Removal)
- Loosen the hose clamp [A] and disconnect the water hose [B] at the coolant inlet port of the water pump [C].

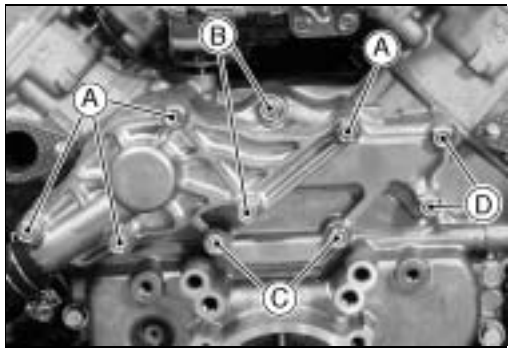
- Unscrew the water pump mounting bolts in the order shown, and remove the water pump assembly.



NOTE

○ *Note the position of different length of bolts so they can be installed in their original positions.*

Bolt Dimensions
[A] Bolt M8, L = 80 mm (3.15 in)
[B] Bolt M8, L = 45 mm (1.77 in)
[C] Bolt M8, L = 30 mm (1.18 in)
[D] Bolt M8, L = 60 mm (2.36 in)

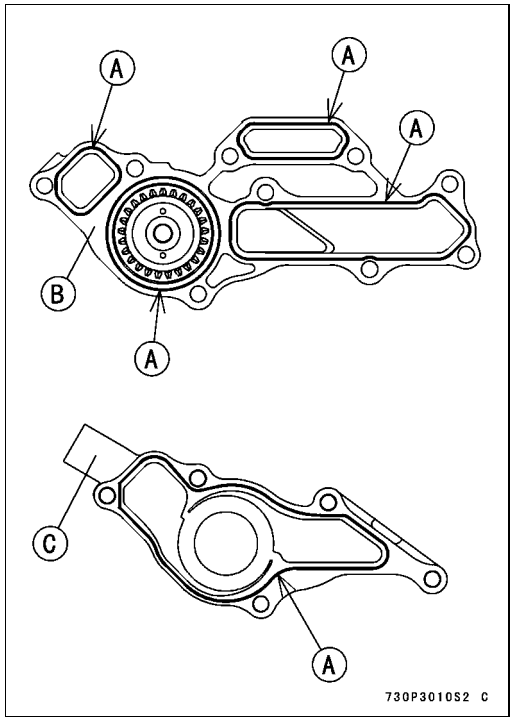


Water Pump Installation

- Chip the old gasket off the mating surface of the pump-cover and pump housing.
- Apply sealant bead [A] (wide 1 ∼ 2 mm) to the mating surface of the pump housing [B] and pump cover [C] as shown in the figure.
  Sealant - Kawasaki Bond (Silicone Sealant): 56019–120

CAUTION
Does not get the sealant into the water line hole on the crankcase or crankcase cover.

- Be sure to suitable set the pump gear to be meshed with the cam gear when installing the pump assembly. Do not force the pump into position.

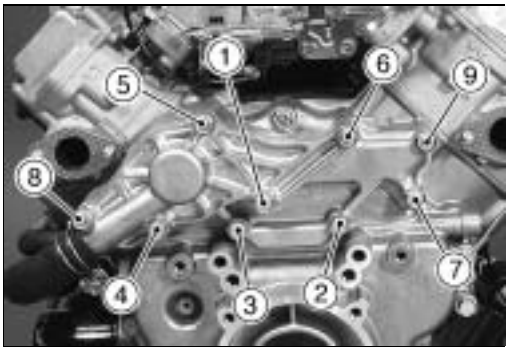


Water Pump

- Install the mounting bolts and tighten them in the order shown.

Torque - Water Pump and Cover Mounting Bolts: 20 N·m (2.0 kg·m, 15 ft·lb)

- Note the position of different length of bolts.



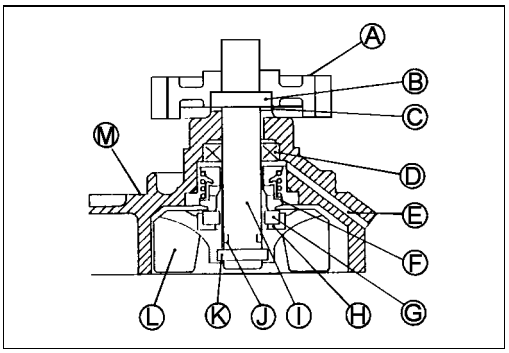
Water Pump Disassembly

For disassembly, follow the steps (1 ~ 10) below (see Illustration).

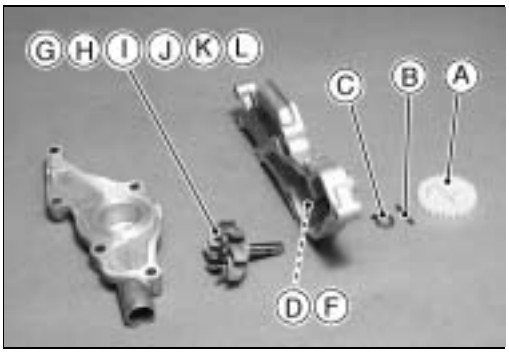
NOTE

○ *Do not attempt to remove the mechanical seal, oil seal and O-ring unless they are to be replaced.*

1. Plastic pump gear [A]
2. Dowel pin [B]
3. Claw washer [C]
4. Extract the impeller subassembly [L] [K] [J] [I] [H] [G] from the pump housing [M]
5. Mechanical seal cartridge [F]
6. Oil seal [D]
7. Dowel Pin [K]
8. Impeller [L]
9. Mating ring [G] and cup-gasket [H]
10. O-ring [J]

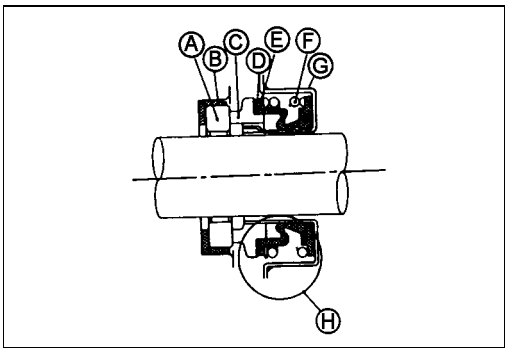


[A] Pump Gear
[B] Dowel Pin (1)
[C] Claw Washer
[D] Oil Seal
[E] Drainage outlet passage
[F] Cartridge
[G] Mating Ring
[H] Cup Gasket
[I] Pump Shaft
[J] O-Ring
[K] Dowel Pin (2)
[L] Impeller
[M] Pump Housing



Internal Parts — Mechanical Seal

[A] Mating Ring (Floating Seat)
[B] Cup Gasket (Cushion Ring)
[C] Seal Ring
[D] Bellows
[E] Spring Retainer
[F] Coil Spring
[G] Casing
[H] Cartridge



Water Pump

Pumps Parts Inspection

- Clean all parts except plastic and rubber parts in a bath of high flash-point solvent and dry them compressed air. Clean non-metal parts with detergent and water, and dry them.
- Inspect the pump housing for damage. Mating surfaces should be smooth and free of burrs and nicks.
- Check the other parts for wear or damage, replace the parts if necessary.

★If the mechanical seal is damaged, the coolant leaks through the seal, and drain through the drainage outlet passage.

★If the oil seal is damaged, the engine oil drain through the drainage passage.

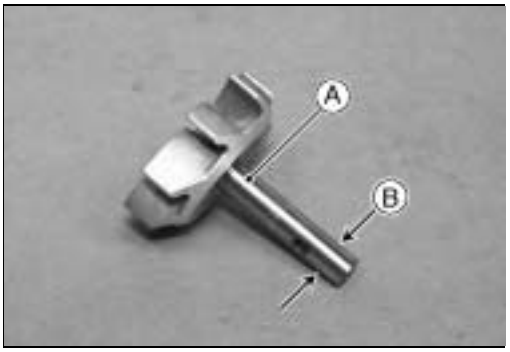
★If the mechanical seal parts are damaged, replace the seal as a set.

- Visually check the impeller.

★If the surface is corroded, or if the blades are damaged, replace all internal pump parts.

- Measure the outside diameter [B] of the impeller shaft [A] with a micrometer at several points.

★If the shaft end diameter is less than service limit, replace the shaft.



Outside Diameter of Impeller Shaft
Service Limit: 9.935 mm (0.3911 in)

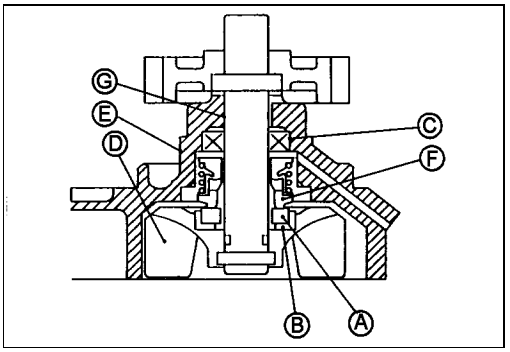
- Measure the inside diameter of the water pump shaft bearing on the pump housing at several points. This bearing is not replaceable. Replace the pump housing and shaft as a set if the inside diameter is more than the service limit.

Water Pump Shaft Bearing Inside Diameter
Service Limit: 10.088 mm (0.3972 in)

Water Pump Assembly

- When installing the mating ring [A] into the cup gasket [B], moisten outside surface of the mating ring with fresh water and then push the ring into the stop end. Do not damage mating surfaces.

○ Pack some amount of high temperature grease into the oil seal [C]. Press in the oil seal using a suitable tools so that the oil seal is flush with the shoulder surface.



NOTE

○ *The oil seal must be assembled with spring loaded lip toward inside of the engine.*

- When installing the impeller [D] sub assembly to the housing [E], coat mating surfaces between the mating ring and seal ring [F] with a clean water.
- To avoid oil seal damage, coat thin film of engine oil on the pump shaft [G], and then carefully insert pump shaft into the housing.

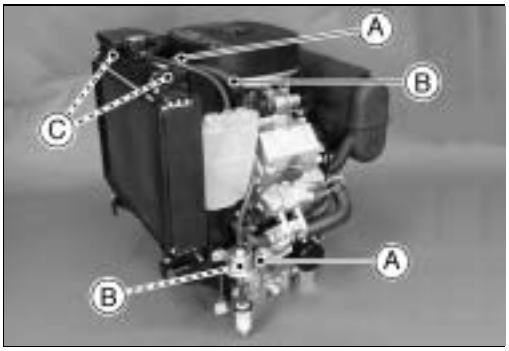
Radiator

Radiator Removal

⚠ WARNING

Always allow the engine to cool before removing the radiator cap. Then remove the cap slowly and carefully to avoid a possible fast discharge of hot coolant which could cause severe burns.

- Remove the radiator cap and drain the coolant in the radiator (see Coolant Draining).
- Loosen the hose clamps [A], and disconnect the radiator hoses [B].
- Unscrew the radiator mounting bolts [C].
- Remove the radiator [A] pulling toward you and up.



Radiator Installation

- Installation is the reverse of removal.

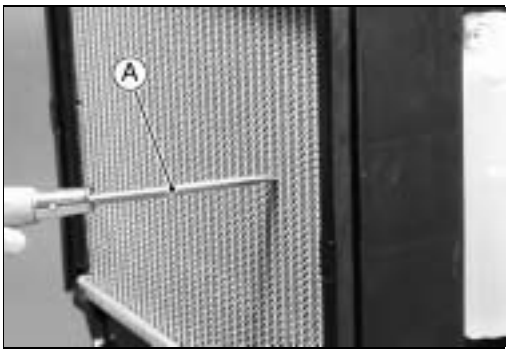
Torque - Radiator Mounting Bolts: 6 N·m (0.6 kg·m, 52 in·lb)

Radiator Inspection

- Check the radiator core.

★If the corrugated fins are deformed, carefully straighten them with the blade of thin screw driver [A].

- Inspect the inlet and outlet tubes for cracks, kinks, dents, and fractured seams. Repair or replace the radiator, if necessary.
- Check for dirt and insects that may be lodged in the radiator. Clean them out by using compressed air or a low-pressure washer.



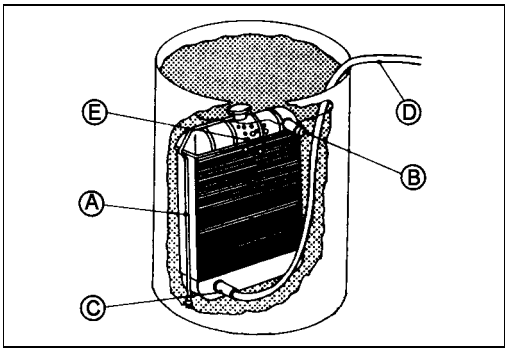
CAUTION

Using high-pressure water, as from a car wash facility, could damage the radiator fins and impair the radiator's effectiveness.

- If the air passages of the radiator core are blocked more than 30% by unremovable obstructions or irreparably deformed fins, replace the radiator with a new one.

★If a radiator leak is detected, by cannot be spotted visually, test it as follows:

1. Install the radiator cap, and plug the overflow tube [A] and inlet pipe [B]. Attach an air hose [D] to the outlet connection [C].
2. Pressurize the inside of the radiator with compressed air to about 50 to 70 kPa (7 to 10 psi).
3. Submerge the radiator in water and look for bubbles [E] which indicate the location of the leak.
4. Repair any leaks or replace it with a new one.



Radiator

- Check the radiator filler neck for signs of damage.
- Check the condition of the top [A] and bottom [B] sealing seats in the filler neck. They must be smooth and clean for the radiator cap to function properly.

Radiator Cap Inspection

The radiator cap has two functions:

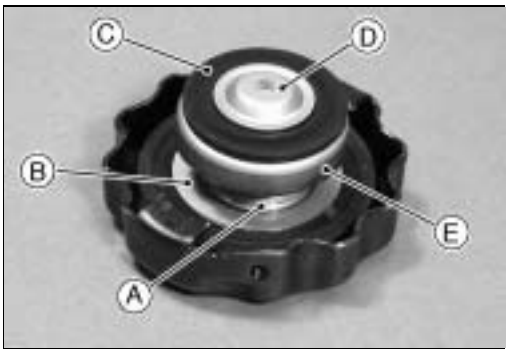
1. Allow atmospheric pressure to enter the cooling system.
2. Prevents coolant escape at normal operating pressure.

A pressure valve [E] in the cap permits the escape of coolant or steam when the pressure in the system rises above the relief pressure.

A vacuum valve [D] in the cap opens when needed to prevent a vacuum in the cooling system.

- Check the condition of the valve spring [A], and the top [B] and bottom [C] valve seats of the radiator cap.

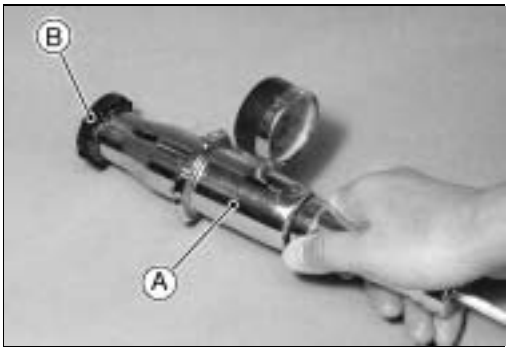
★If any one of them shows visible damage, replace the cap.



- Wet the radiator cap [B] seating surfaces with water or coolant to prevent pressure leaks.
- Install the cap on a cooling system pressure tester [A].
- Watching the pressure gauge, pump the pressure tester to build up the pressure. The cap must retain the pressure at least 6 seconds. Also the cap must open at the pressure shown in the table.

Radiator Cap Relief Pressure

Pressure Valve:	**78 to 98 kPa (0.80 to 1.00 kg/cm^2, 11.3 to 14.2 psi)**
Vacuum Valve:	**4.90 kPa (0.050 kg/cm^2, 0.71 psi)**



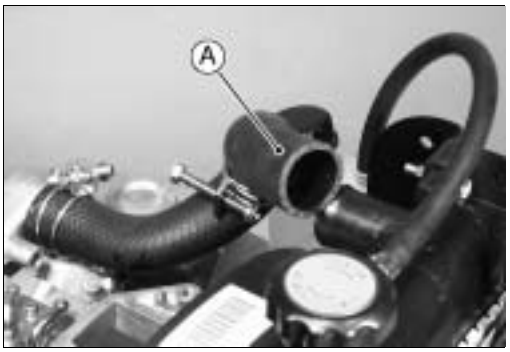
★If the cap cannot hold the specified pressure, or if it holds too much pressure, replace it with a new one.

Radiator Hose Inspection

- In accordance with the Periodic Maintenance Chart, visually inspect the hoses [A] for signs of deterioration. Squeeze the hose. A hose should not be hard and brittle, nor should it be soft or swollen.
- Replace any damaged hose.

NOTE

○ *Hoses can deteriorated on the inside and still appear to be in good condition on the outside.*



Radiator

Radiator Hose Installation Notes

● Install the radiator hoses being careful to follow bending direction (see Exploded View). Avoid sharp bending, kinking, flatting, or twisting.

NOTE

○ *Locate the hose clamps [A] properly over the connections. A pressurized cooling system will blow a hose that is not installed properly. Tighten the hose clamps securely.*

Torque - Radiator Hoses Clamps Bolts: 1.2 N·m (0.12 kg·m, 11 in·lb)

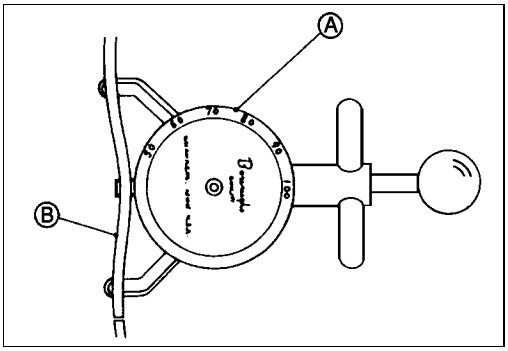
Cooling Fan, Fan Belt

The only service on the cooling fan is to be srue the fan blades are not deformed, and the blade tips are far enough from the air duct to not strike the duct. The fan belt should be neigher too tight nor too loose.

Belt Tension Check

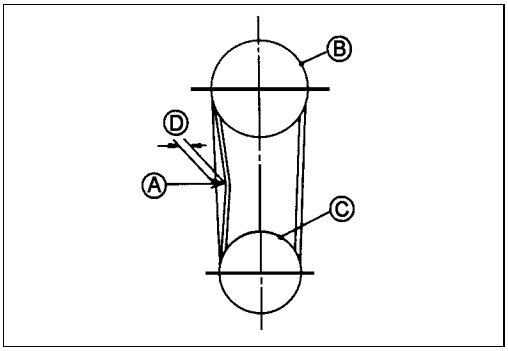
- Remove:
  Radiator (see Radiator Removal)
- Measure the belt tension using a proper belt tension gauges [A]. Follow the manufacturer's instructions for use of the belt tension gauge. The belt tension is adjusted between 25 kg (55 lb) and 40 kg (88 lb) in the factory for the manufacturing standard.

★If the belt tension is less than specified limit, adjust or replace the belt [B].



Belt Tension Service Limit
18 kg (40 lb)

- If the belt tension gauge is not available, push [A] the belt with a thumb strongly at the middle between sheaves [B] [C]. The slack [D] of the belt correspond the measurement of the belt tension gauge are as follow. Use the table as a guide line.

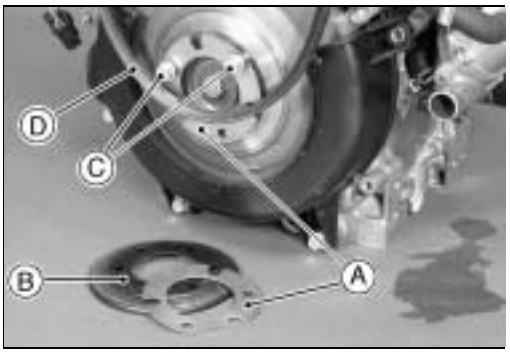


Belt Tension Measurement Slacks

25 kg (55 lb)	**12 mm (0.47 in)**
40 kg (88 lb)	**9 mm (0.35 in)**
18 kg (40 lb)	**17 mm (0.67 in)**

Belt Replacement

- When replacing the fan belt, use only factory recommended belt with the proper length. To compensate for the belt length allowance, select appropriately sized shim(s) [A] from the table to obtain proper level of the belt tension (25 ~ 40 kg).



Fan Belt		A	B	C	D	E	F
No of shim	92180-2013*	1	1	2	1	2	2
	t = 0.6 mm						
	92180-2014*	—	—	—	1	1	1
	t = 1.2 mm						

*Part Number — A Belt: smaller allowance
t = Thickness of shim — F Belt: Bigger allowance

NOTE

○ *When tightening the sheave/hub [B] mounting bolts [C], rotate the fan in either direction to avoid pinching the belt [D].*

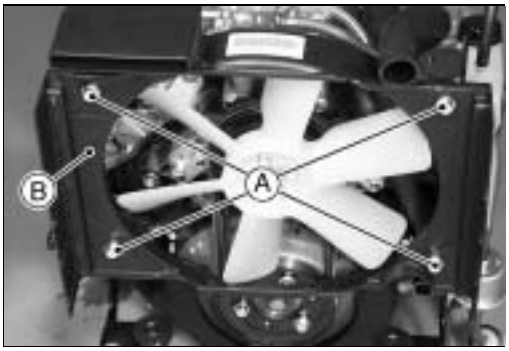
Torque - Sheave/Hud Mounting Bolts: 20 N·m (2.0 kg·m, 15 ft·lb)

Drive Belt Specification
MITSUBOSHI — 59011-2058

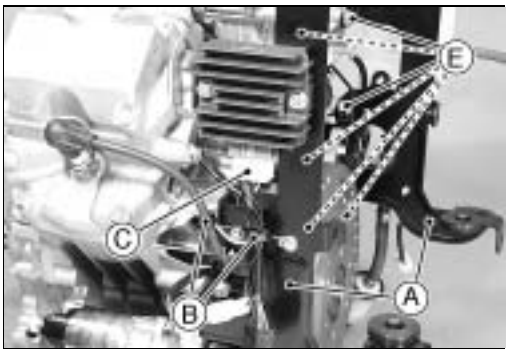
Cooling Fan, Fan Belt

Cooling Fan, Fan Belt Removal

- Remove:
  Radiator (see Radiator Removal)
- Remove the radiator guide.
  - Unscrew the mounting bolts [A] and remove the radiator guide [B].



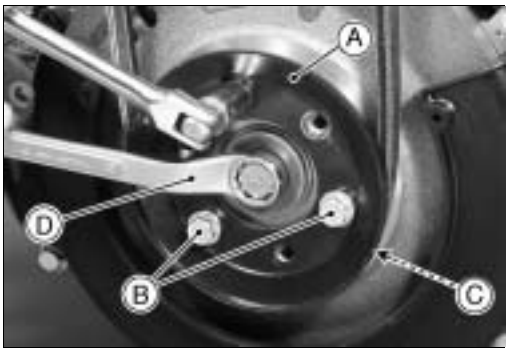
- Remove the radiator brackets [A].
  - Unfold the three clamps [B] that hold the harness, wire and fuel overflow pipe connecting to the carburetor.
  - Disconnect the coupler [C] and fuel overflow pipe [D] connecting to the carburetor.
  - Unscrew the bracket mounting bolts [E] (6 bolts) and remove the radiator brackets.



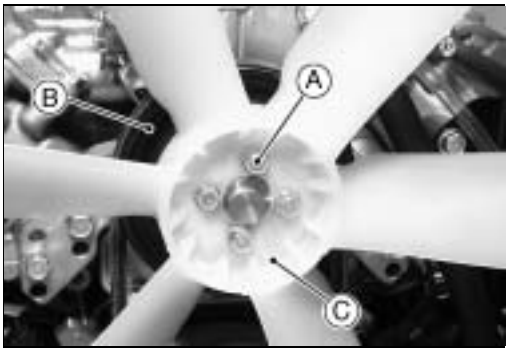
- Hold the fan drive sheave/hub [A] with a suitable spanner [D] to prevent rotating the sheave/hub.
- Unscrew the sheave/hub mounting bolts [B], and take off the sheave/hub and shim(s) [C].
- Remove the fan belt rolling over the fan sheave.

NOTE

  - *When removing the fan belt, note the belt so that it may be reinstalled on the sheaves to rotate same direction as original installation.*

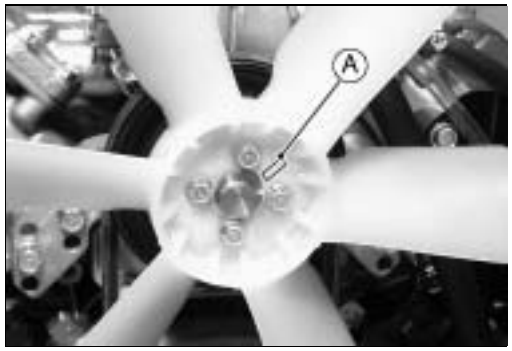


- Unscrew the mounting bolts [A], and take off the cooling fan [C] and fan sheave [B].



Cooling Fan, Fan Belt

Cooling Fan, Fan Belt Installation

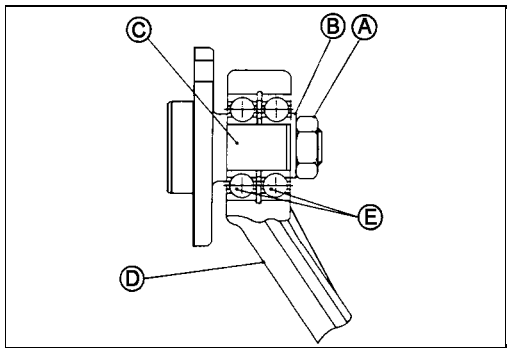


- Install the cooling fan as “AISHIN” raised lettering [A] on the fan boss facing toward the radiator.
- Clean the drive belt by wipping with a clean cloth. Immediately wipe off any spilled oil or grease. Do not use solvent.
- Install the belt on the sheave to rotate same direction as original installation.
- When tightening the sheave/hub bolts, rotate the fan in either direction to avoid pinching the belt.
- Check the belt tension.

Cooling Fan, Fan Belt Inspection

- Be sure the fan blades are straight. Deformed blades reduce the cooling system efficiency and throw the fan out of balance.
- Check for excessive side wall wear of the sheaves and belt, replace if necessary. The belt and sides of the sheaves should wear evenly.
- Check to be sure dirt has not lodged and packed in the sheave V-grooves.
- Check the belt for swells or lumps, replace if necessary.

Fan Bearing Removal



- Remove:
  Fan Mounting Bracket [D]
- Unscrew the fan shaft nut [A], and remove the shaft [C] and washer [B].
- To check the ball bearing [E], rotate the bearing slowly by finger; if any roughness is noted, the bearing should be replaced.

⚠ WARNING

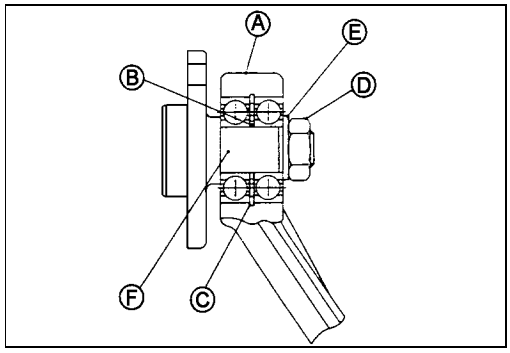
Do not allow a flame or heating element to come in direct contact with the oil. Heat the oil in a well-ventilated area. Plan a safe handling procedure to avoid burns.

- To remove the ball bearing, heat the bearing housing in a hot 150°C (320°F) oil.
- Use a heat shield gloves to prevent burns.
- Place the bearing housing on a bench with bearing side up and take off the bearing with a suitable tools.

CAUTION

Do not remove the bearing unless it is necessary. Once it has been removed, it must be replaced.

Fan Bearing Installation



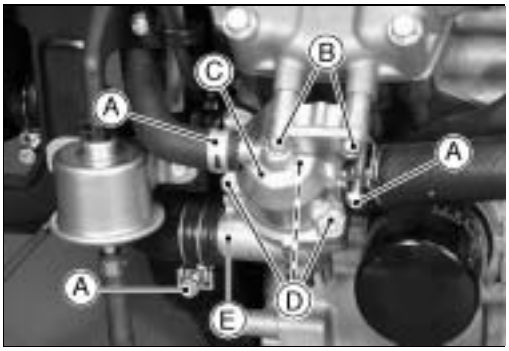
- Coat the bearing surfaces with a light film of engine oil.
- Use a bearing driver, press in the fan side bearing flush with the housing [A].
- Install opposite side of bearing using a bearing driver until it stops at the stop [spacer [B]] in hole.
- Install the fan shaft [F], washer [E] and nut [D], then tighten the nut to the specified torque (see Exploded View).

Torque - Cooling Fan Shaft Nut: 20 N·m (2.0 kg·m, 15 ft·lb)

Thermostat

Thermostat Removal and Installation

- Drain the coolant (see Coolant Draining).
- Loosen the hose clamps [A], and pull off the three coolant hoses.
- Unscrew the mounting bolts [B], and remove the thermostat-body [C].
- Unscrew the bolts [D], and separate the thermostat upper-body [C] from the lower-body [E].

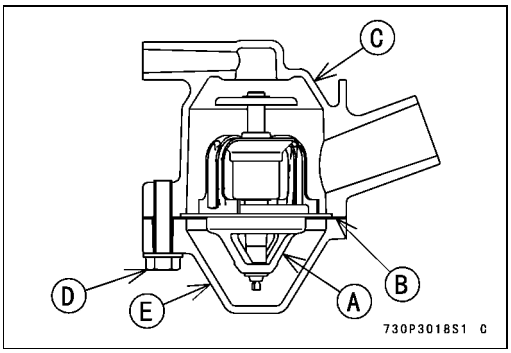


- Remove the thermostat [A] from the upper-body [C].
  [B] Gasket
  [D] Bolts
  [E] Lower-Body
- Installation is reversal of removal (refer to the illustration).

○ Replace the gasket [B] with a new one.

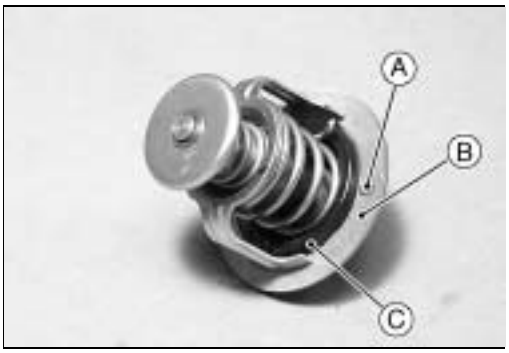
○ Tighten the bolts [D] to the specified torque.

Torque - Thermostat-Body Tightening Bolts: 10 N·m (1.0 kg·m, 87 in·lb)



Thermostat Inspection

- Remove the thermostat, and check the jiggle valve [A] for sticking or binding on the flange [B] due to accumulation of a rust, scale or lime. Clean up the valve to ensure free movement of the valve [C], if necessary.



- Inspect the thermostat valve [A] at room temperature.

★If the valve is open, replace the valve with a new one.

- To check valve opening temperature, suspend the thermostat and an accurate thermometer [B] in a container filled with a water.
- Place the container over a source of heat and gradually raise the temperature of the water while stirring the water gently.

○ Watch the valve. The valve should begin to open at the temperature specified.

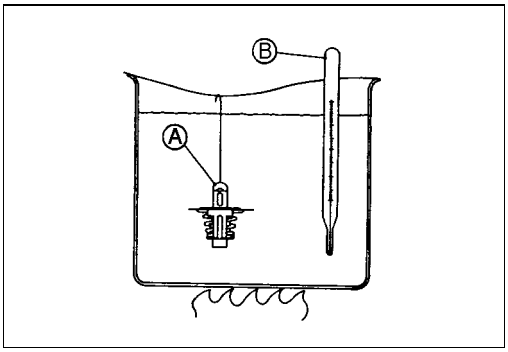
○ It should be fully opened to 8 mm (0.31 in) or more at the temperature specified.

Thermostat Valve Specification

Begin Opening	**80.5 to 83.5°C (177 to 182°F)**
Full Open	**95°C (203°F)**

The thermostat and thermometer must not touch the container sides.

★If the thermostat fails any of these check, replace it.



Thermo Switch

When coolant temperature rises above 111°C (232°F), the thermo switch detects this and turns on a warning light on dash. Whenever you start the engine, make sure the warning light is not on in started engine.

If the warning light comes on, stop the engine immediately, and check the cooling system for over heating. Over heating can caused by:

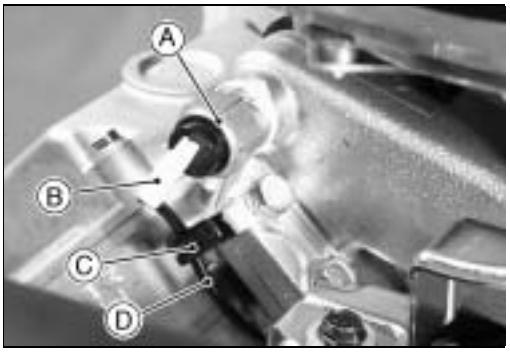
Lack of coolant
Loose or slipping fan belt
Clogging of cooling system
Malfunction water pump or thermostat

Check the coolant level and temperature frequently.

Thermo Switch Removal and Installation

- Drain the coolant (see Coolant Draining).
- Unfold the clamp [C] that hold the switch lead [D].
- Disconnect the switch lead terminal [B].
- Unscrew the thermo switch [A] and remove it.
- When installing the thermo switch [A], apply a non-permanent locking agent to the threads and tighten the switch.

Torque - Thermo Switch: 27 N·m (2.8 kg·m, 20 ft·lb)



Thermo Switch Inspection

- Using a ohmmeter, check to see that only the connections in the table have continuity.

★If the switch has an open or short, repair it or replaced it with a new one.

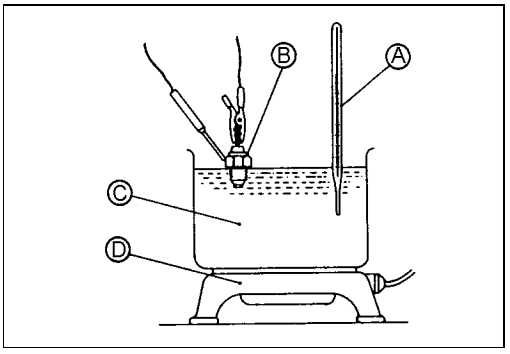
Thermo Switch Connections
• Rising temperature:
From Off to On at 108 - 114°C (226 - 237°F)
• Falling temperature:
From On to Off at 101 - 107°C (214 - 225°F)
ON: Continuity
OFF: Infinit

- Suspend the switch [B] in a container of coolant [C] so that the temperature sensing projection and threaded portion are submerged.
- Suspend an accurate thermometer [A] in the coolant.

NOTE

○ *The switch and thermometer must not touch the container sides or bottom.*

- Place the container over a source of heat [D] and gradually raise the temperature of the coolant while stirring the coolant gently.



Engine Top End

Table of Contents

Exploded View....4-2
Specifications....4-4
Cylinder Head....4-5
- Compression Measurement....4-5
- Cylinder Head Assembly Removal....4-5
- Cylinder Head Assembly Installation....4-6
- Push Rod Installation....4-7
- Push Rod Inspection....4-7
- Valve Mechanism Removal/Installation....4-8
- Cleaning and Inspection....4-9

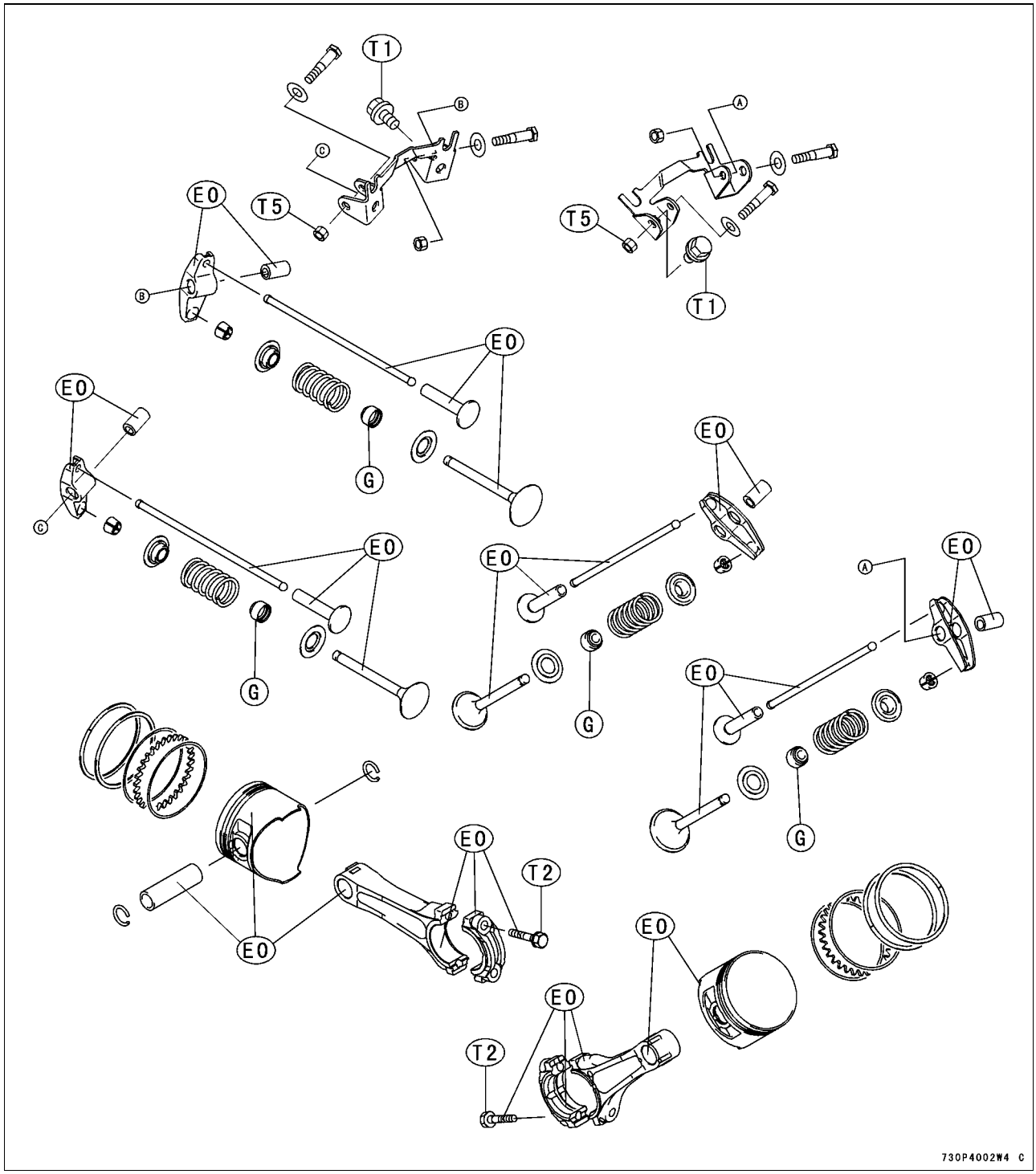
Valves....4-11
- Valve Clearance Inspection....4-11
- Valve Clearance Adjustment....4-11
- Valve Seat Inspection....4-12
- Valve Seat Repair....4-12
- Valve Head Thickness....4-14
- Valve Stem Runout....4-15
- Valve Stem Diameter....4-15
- Valve Guide Inside Diameter....4-15
- Valve Spring Inspection....4-15

Cylinder, Piston....4-16
- Piston Removal....4-16
- Piston Installation....4-17
- Piston/Cylinder Seizure....4-18
- Piston Cleaning....4-19
- Piston Ring and Ring Groove Wear....4-19
- Piston Ring End Gap....4-20
- Piston Pin, Piston Pin Hole, and Connecting Rod Wear....4-20
- Piston Diameter....4-21
- Cylinder Inside Diameter....4-21
- Cylinder Boring and Honing....4-21

Muffler....4-23
- Muffler Assembly Removal....4-23
- Muffler Assembly Installation....4-23
- Inspection....4-23

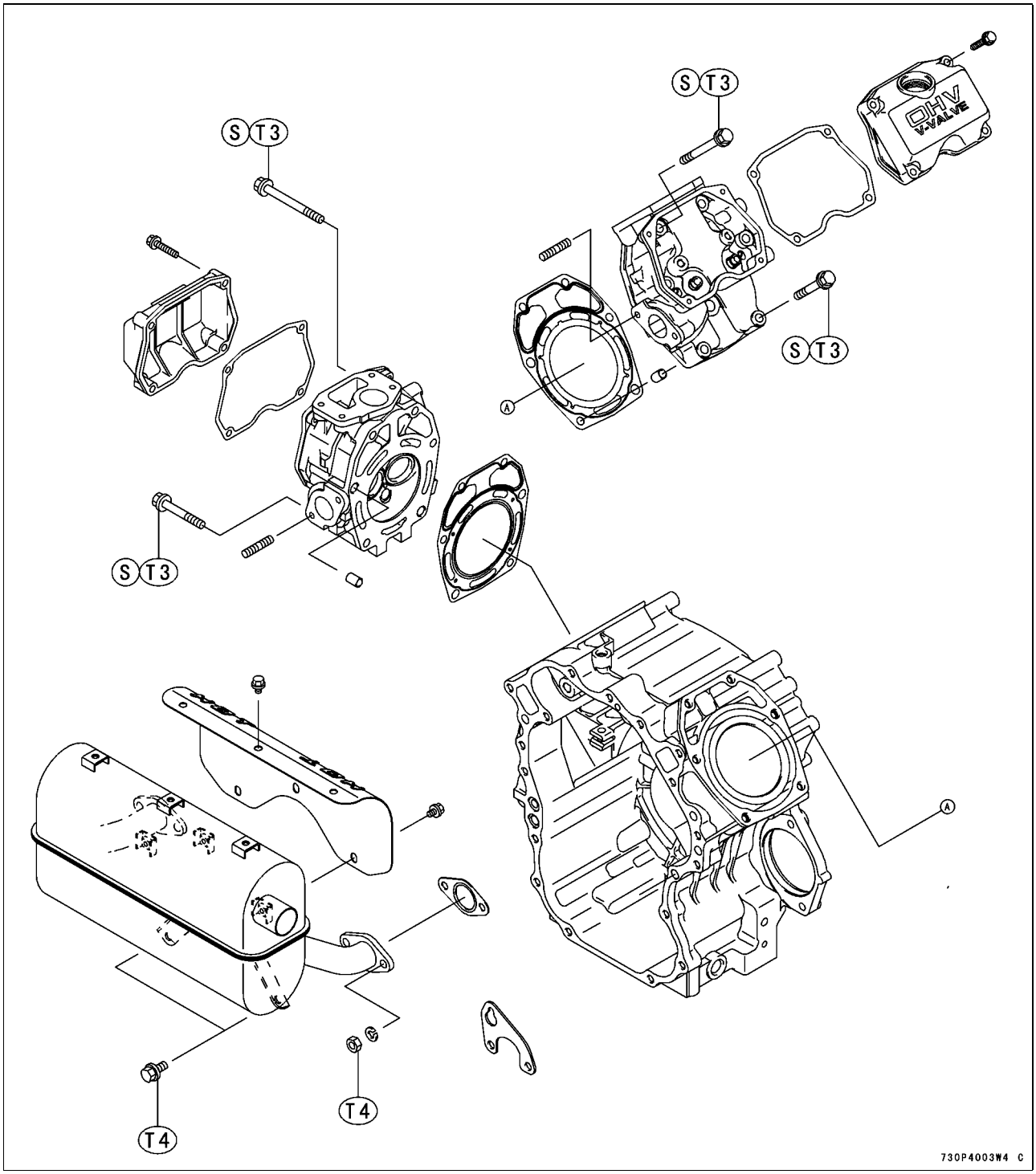
4-2 ENGINE TOP END

Exploded View



EO: Apply engine oil.
G: Apply grease.
T1: 22 N·m (2.2 kg·m, 16 ft·lb)
T2: 21 N·m (2.1 kg·m, 15 ft·lb)
T5: 11 N·m (1.1 kg·m, 96 in·lb)

Exploded View



S: Follow the specific tightening sequence.
T3: 27 N·m (2.8 kg·m, 20 ft·lb)
T4: 20 N·m (2.0 kg·m, 15 ft·lb)

4-4 ENGINE TOP END

Specifications

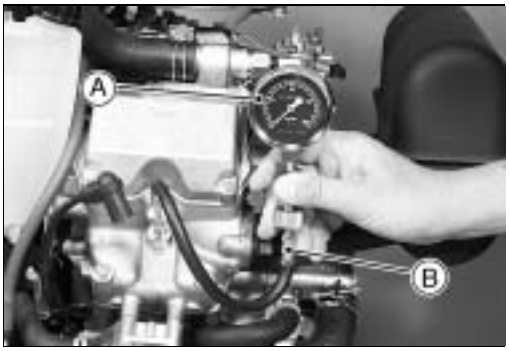
Item		Service Limit
Cylinder Head:		
Cylinder compression (MIN)		[1171 kPa (170 psi)] (MIN)
Cylinder head warp		0.06 mm (0.002 in.)
Valves:		
Valve seating surface width	Intake, Exhaust	2.0 mm (0.08 in)
Valve head thickness	Intake, Exhaust	0.6 mm (0.024 in.)
Valve stem runout	Intake, Exhaust	0.05 mm (0.002 in.)
Valve stem diameter	Intake, Exhaust	6.935 mm (0.2730 in.)
Valve guide inside diameter	Intake, Exhaust	7.080 mm (0.2787 in.)
Valve spring free length	Intake, Exhaust	31.00 in (1.22 in.)
Rocker arm push rod runout	Intake, Exhaust	0.50 mm (0.02 in.)
Rocker arm collar outside diameter	Intake, Exhaust	10.914 mm (0.4297 in)
Rocker arm bearing inside diameter	Intake, Exhaust	11.052 mm (0.4351 in.)
Cylinder, Piston		
Piston ring/groove clearance	Top, Second	0.15 mm (0.006 in.)
Piston ring thickness	Top, Second	1.40 mm (0.055 in.)
Piston ring end gap	Top, Second	1.0 mm (0.04 in.)
	Oil	1.2 mm (0.05 in.)
Piston pin outside diameter		18.960 mm (0.7465 in.)
Piston pin hole inside diameter		19.080 mm (0.7512 in.)
Connecting rod small end inside diameter		19.060 mm (0.7504 in.)
Cylinder inside diameter:	Standard Cylinder	78.080 mm (3.0740 in.)
	0.50 mm Oversize	78.580 mm (3.0937 in.)
Piston outside diameter		77.700 mm (3.0590 in.)
Cylinder bore out round		0.056 mm (0.0022 in.)

Item		Standard
Valve clearance	Intake, Exhaust	0.15 mm (0.006 in.)
Valve seating surface angle	Intake, Exhaust	45°
Valve seating surface width	Intake, Exhaust	0.5 to 1.1 mm (0.02 to 0.043 in.)
Valves guide inside diameter	Intake, Exhaust	7.000 to 7.015 mm
		(0.2756 to 0.2762 in.)
Cylinder bore diameter:		
Standard cylinder		78.000 to 77.980 mm
		(3.0709 to 3.0701 in.)
0.50 mm Over size		78.500 to 78.480 mm
		(3.0905 to 3.0898 in.)

Special Tools - Piston Ring Pliers: 57001-115
Compression Gauge : 57001-221
Piston Ring Compression Grip: 57001-1095
Piston Ring Compression Belt, ϕ67 - ϕ79: 57001–1097
Valve Seat Cutter, 45° - ϕ35.0 : 57001-1116
Valve Seat Cutter, 30° - ϕ30.0 : 57001-1120
Valve Seat Cutter Holder Bar: 57001–1128
Compression Gauge Adapter M14 x 1.25: 57001–1159
Valve Seat Cutter, 30° - ϕ33.0 : 57001-1199
Valve Seat Cutter Holder, ϕ6: 57001–1360

Cylinder Head

Compression Measurement



- Before measuring compression, do the following.
  - Be sure the battery is fully charged.
  - Thoroughly warm up the engine so that engine oil between the piston and cylinder wall will help seal compression as it does during normal running.
  - Stop the engine.
- Disconnect the spark plug caps of each cylinder and remove the spark plugs.
- Attach the compression gauge assembly firmly into one plug hole.

Special Tool - Compression Gauge: 57001–221 [A]
Compression Gauge Adapter: 57001–1159 [B]

- Ground the spark plugs to the engine.

⚠ WARNING

To avoid fire, do not ground the spark plugs in closed positions to the plug holes. Keep the plugs as far away as possible from the plug holes.

- Using the starter motor, turn the engine over with the throttle fully open until the compression gauge stops rising; the compression reading obtainable.
- Repeat the measurement to the other cylinder.

Cylinder Compression (MIN): 1171 kPa (170 psi)

★If the compression is higher than the specified value, the piston rings, cylinder and valves are probably in good condition.

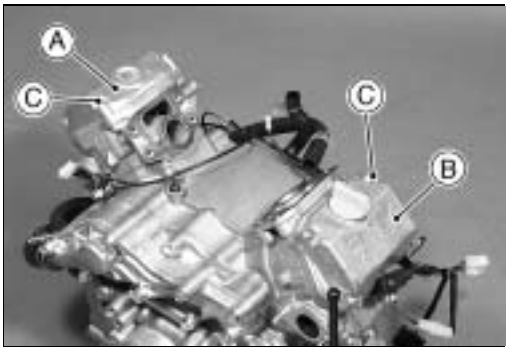
★If the compression is too high, check the following.

1. Carbon build-up on the piston head and cylinder head - clean off any carbon on the piston head and cylinder head.
2. Cylinder head gasket - use only the proper gasket. The use of a gasket of incorrect thickness will change the compression.
3. Valve guides and piston rings - rapid carbon accumulation in the combustion chamber may be caused worn valve guides and/or worn piston oil rings. This may be indicated by white exhaust smoke.

★If cylinder compression is lower than the (MIN), check the following:

1. Gas leakage around the cylinder head - replace the damaged gasket and check the cylinder head warp.
2. Condition of the valve seating.
3. Valve clearance.
4. Piston/cylinder wear, piston seizure.
5. Piston ring, piston ring groove.

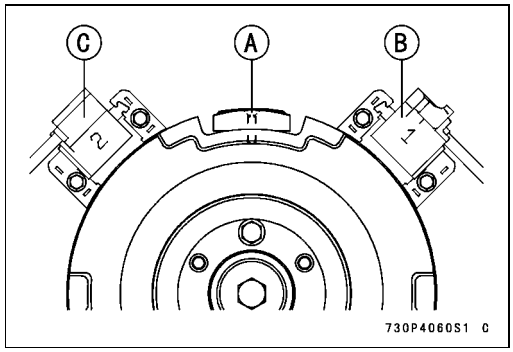
Cylinder Head Assembly Removal



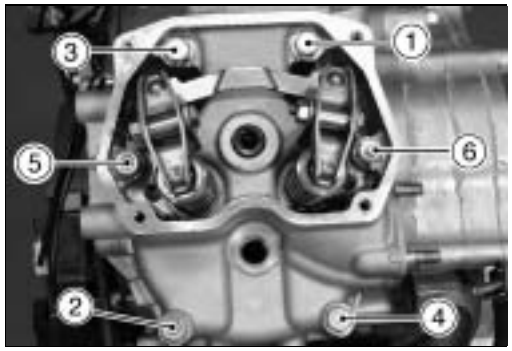
- Remove:
  Radiator and it's Bracket
  Air Cleaner and Carburetor
  Muffler
  Intake Manifold
  Spark Plug
- Unscrew the rocker cover mounting bolts [C], and remove the covers [A], [B] and gaskets.
  [A] Rocker Cover (No. 1 Cylinder)
  [B] Rocker Cover (No. 2 Cylinder)
  [C] Mounting Bolts (8 bolts)

Cylinder Head

- When removing the cylinder head, set the flywheel at top dead center (T.D.C) of power stroke each cylinder.
- ○ When setting the flywheel at T.D.C of #1 cylinder, align the flywheel magnet [A] with No.1 ignition coil [B]. If it is not at T.D.C, turn the flywheel clockwise one turn (360°).
- ○ When setting the flywheel at T.D.C of #2 cylinder, turn the flywheel-magnet [A] clockwise from position at T.D.C of #1 Ccylinder to at No.2 ignition coil [C]. If it is not at T.D.C, turn the flywheel clockwise with one turn (360°).



- Loosen the cylinder head bolts 1/4 turn in the sequence shown.



CAUTION

If the above procedure is not followed, the cylinder head may be warped during removal.

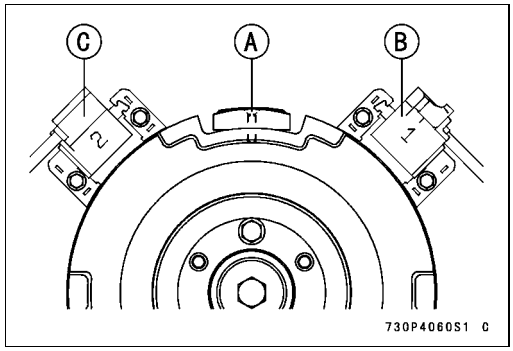
- Repeat the sequence until all bolts are removed and lift off the cylinder head assembly.

NOTE

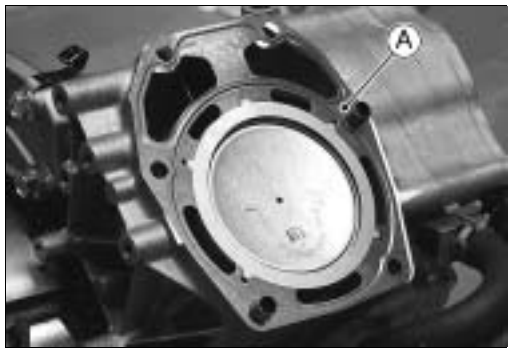
- ○ *Mark the push-rods so they can be installed in their original position during assembly.*

Cylinder Head Assembly Installation

- When installing the cylinder head, set the flywheel at T.D.C of power stroke each cylinder.
- ○ When setting the flywheel at T.D.C of #1 cylinder, align the flywheel magnet [A] with No.1 ignition coil [B]. If it is not at T.D.C, turn the flywheel clockwise one turn (360°).
- ○ When setting the flywheel at T.D.C of #2 cylinder, turn the flywheel-magnet [A] clockwise from position at T.D.C of #1 cylinder to at No. 2 ignition coil [C]. If it is not at T.D.C, turn the flywheel clockwise with one turn (360°).
- Clean the mating surfaces of the cylinder heads and cylinder.
- Install the knock pins on the cylinder.



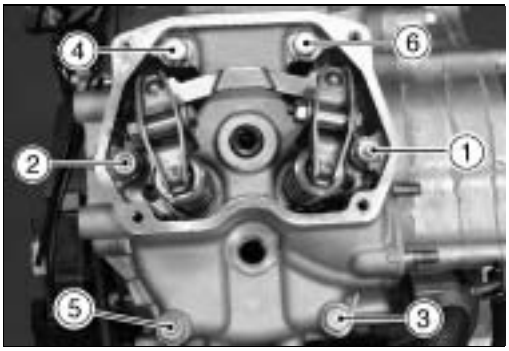
- Put a new gaskets [A] and the cylinder head assemblies on each cylinder, then let the cylinder heads with push rods aligned under the rocker arms (see Valve Mechanism Removal/Installation, Push Rod Installation).



NOTE

- ○ *As the head gaskets are coated with sealing agents, be careful not to injure the surfaces of them.*

Cylinder Head



- Install the head bolts noting the position of different length bolts.
- Then tighten the head bolts to the specification (see Exploded View).
- ○ Follow the sequence shown, tighten the head bolts to 15 N·m (1.5 kg·m, 11 ft·lb).
- ○ Tighten the bolts in sequence 3.0 N·m (0.3 kg·m, 27 in·lb) at a time until torque on each bolt is 27 N·m (2.8 kg·m, 20 ft·lb).

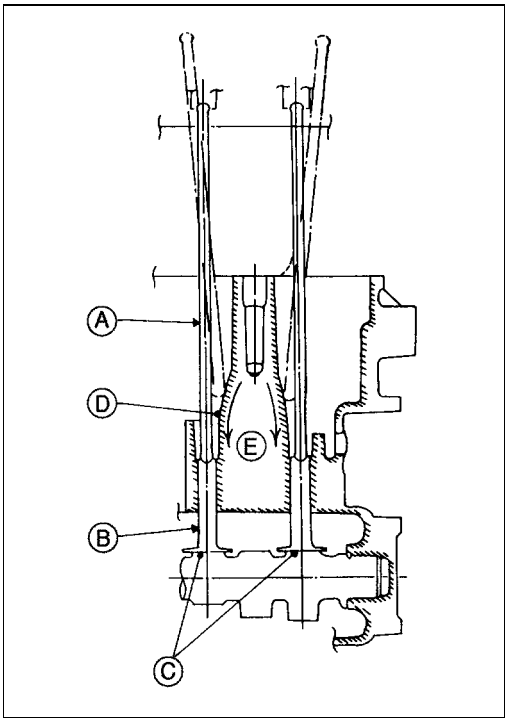
Torque - Cylinder Head Bolts: 27 N·m (2.8 kg·m, 20 ft·lb)

CAUTION

A torque wrench must be used to prevent loose or overtight the head bolts which may result in warping of the cylinder head.

Push Rod Installation

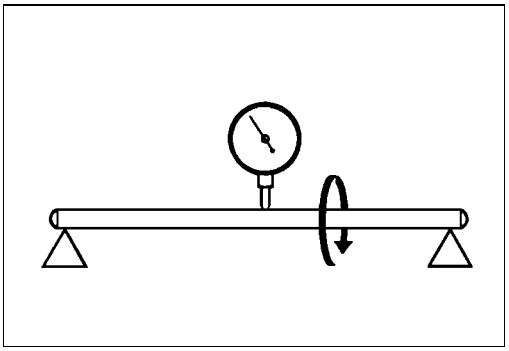
- When installing the push rod, set the flywheel at T.D.C of power stroke each cylinder. (see Cylinder head Assembly Installation)



- Install the push rods in their original positions on each cylinder.
- ○ To install the push rod in a correct position on the tappet, insert the push rod so end of the push rod is sliding down along inside wall of the crankcase and position the push rod end on the tappet.
- Check both intake and exhaust push rods on each cylinder are lowest position on the cam lobes, if not turn the flywheel clockwise one turn (360°).
- Be sure the end of the push rods are correctly seated on the tappets.

[A] Push Rods
[B] Tappets
[C] Lowest Cam Lobes
[D] Inside Walls
[E] Sliding Down

Push Rod Inspection



- Place the rocker arm push rod in V blocks that are as far apart as possible, and set a dial gauge on the rod at a point halfway between the blocks. Turn the rod to measure the runout. The difference between highest and the lowest dial readings is the amount of runout.
- ★ If the runout exceeds the service limit, replace the rod.

Rocker Arm Push Rod Runout
Service Limit: 0.5 mm (0.02 in.)

Cylinder Head

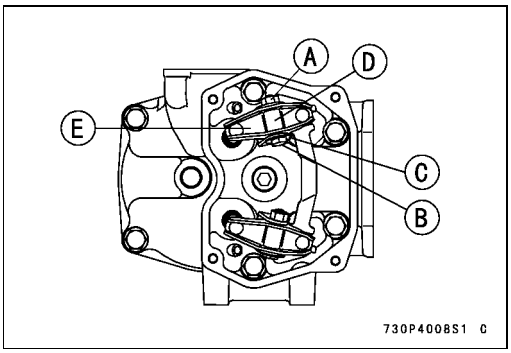
Valve Mechanism Removal/Installation

- Remove the cylinder head assembly. (see Cylinder Head Assembly Removal)

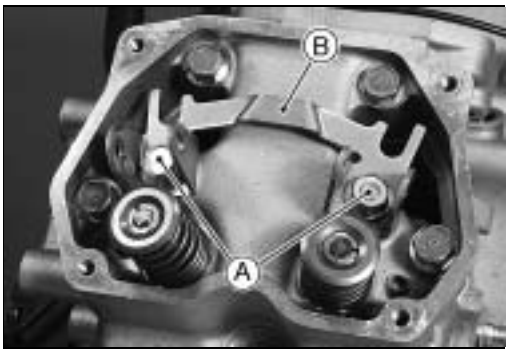
NOTE

○ *When removing the valve mechanism parts, note their position so that they may be reinstalled in their original position during assembly.*

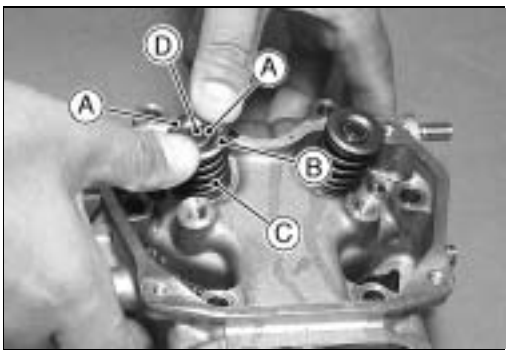
- Remove:
  Nut [A]
  Bolt [B]
  Washer [C]
  Collar [D]
  Rocker Arm [E]



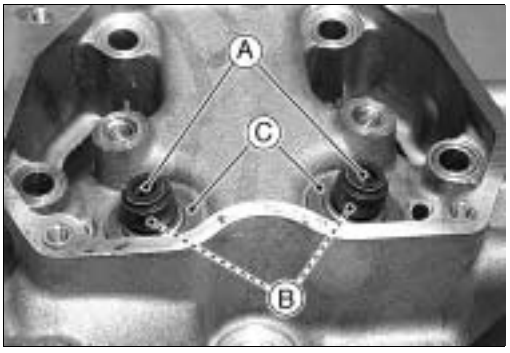
- Remove:
  Bolts [A]
  Bracket [B]



- Support the valve head in the combustion chamber with a suitable block.
- To remove the collets [A], push down the valve retainer [B] with thumbs and remove the collets.
- Remove the spring [C] and valve [D] .



- Remove the stem seals [A].



NOTE

○ *It is not necessary to remove the stem seal unless it is being replaced.*
○ *Bottom spring retainer [C] can only be removed with stem seal.*
○ *Valve guide [B] is not replaceable, do no remove it.*

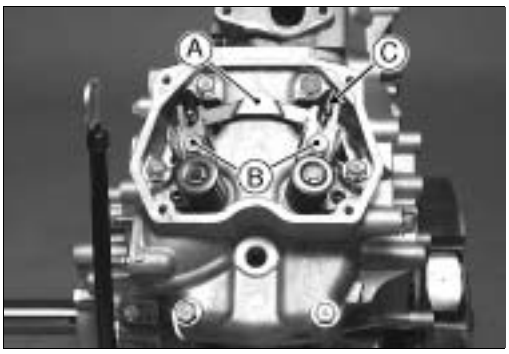
Cylinder Head

● Valve Installation.
○ Apply engine oil to the valve stem to avoid damaging the stem seal.
○ Check to see that the valve moves smoothly up and down in the guide.
○ Check to see that the valve seats properly in the valve seat. If it does not, repair the valve seat.
● Valve installation is the reverse of removal.
● Install the cylinder head assembly. (see Cylinder Head Assembly Installation)
● Rocker Arm Installation
○ Set the flywheel at T.D.C of power stroke each cylinder. (see Cylinder Head Assembly Installation)

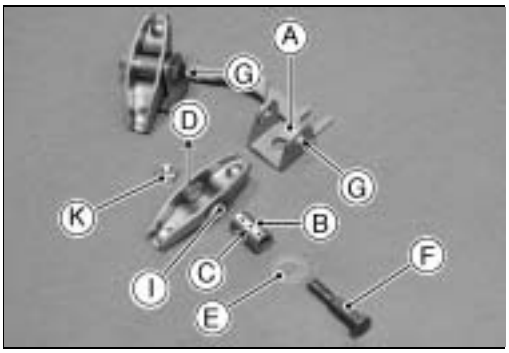
○ Install the bracket [A] on the cylinder head with two bolts [B] and tighten them.

Torque - Rocker Arm Bracket Mounting Bolt:
22 N·m (2.2 kg·m, 16 ft·lb)

○ Install the push rods by inserting into “U” notch [C] on the bracket [A]. (see Push Rod Installation)



○ Insert the collar [B] into the rocker arm hole [I] so that the groove [C] of the collar face toward upside [D], then set them on the bracket [A].
○ Insert the washer [E] onto bolt [F], and insert the bolt [F] into the hole at the rightside [G] of the bracket [A] and through the collar installed with rocker arm.
○ Install the nut [K] onto the bolt [F], and tighten the nut temporarily.
○ Position the push rod end on to rocker arm dent.



Cleaning and Inspection

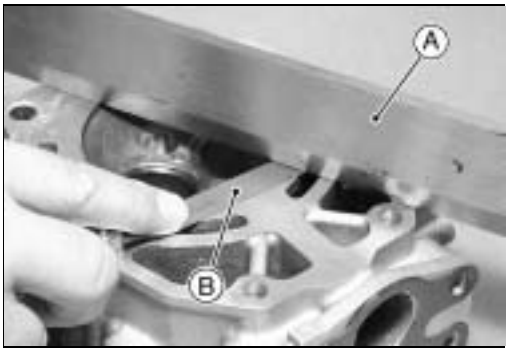
● Scrape the carbon deposits from the head and exhaust port with a suitable tool [A].
○ To avoid gouging, use scrapers that are made of a material that will not cause damage.
● Clean the head in a bath of high flash-point solvent and dry it with compressed air.

⚠ WARNING

Clean the cylinder head in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low flash-point solvent to clean the cylinder head. A fire or explosion could result.

● Lay a straightedge [A] across the mating surface of the head at several different points, and measure warp by inserting a thickness gauge [B] between the straightedge and head.
★ If warp exceeds the service limit, repair the mating surface. Replace the cylinder head if the mating surface is badly damaged.

Cylinder Head Warp
Service Limit: 0.06 mm (0.002 in.)

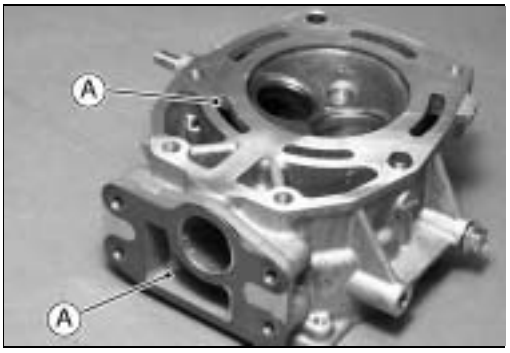


Cylinder Head

- Check the cylinder head for cracks or other damage.
- Cracks not visible to the eye may be detected by coating the suspected area with mixture of 25% kerosene and 75% light engine oil.
- Wipe the area dry and immediately apply a coating of zinc oxide dissolved in wood alcohol. If a cracks is present, the coating will become discolored at the defective area.
- If a cracks is present in the cylinder head, replace it.
- Inspect the mating surface for burrs and nicks.

- Inspect the cylinder head for accumulation of rust, scale and lime in the water jacket [A].

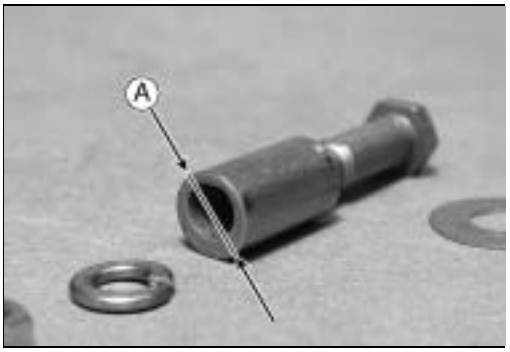
★If this accumulation is observed, flush the cooling system (see Flushing in Cooling System chapter).



- Measure the diameter [A] of the rocker arm collar with a micrometer at several points of bearing the rocker arm.

★If the outside diameter is less than the service limit, replace the rocker arm collar.

Rocker Arm Collar Outside Diameter
Service Limit: 10.914 mm (0.4297 in)



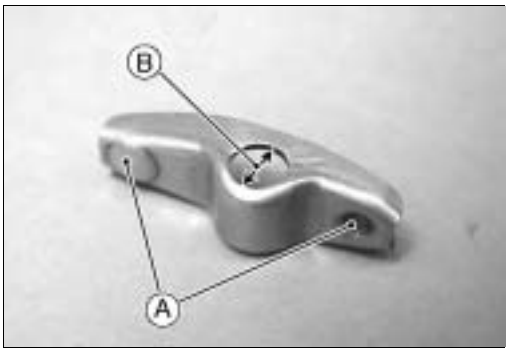
- Clean and inspect the rocker arm where it touches the push rod and valve stem.

★If the contact points [A] are worn or damaged, replace the rocker arm.

- Measure the inside diameter of the rocker arm bearing [B] at several points using a dial bore gauge or inside micrometer.

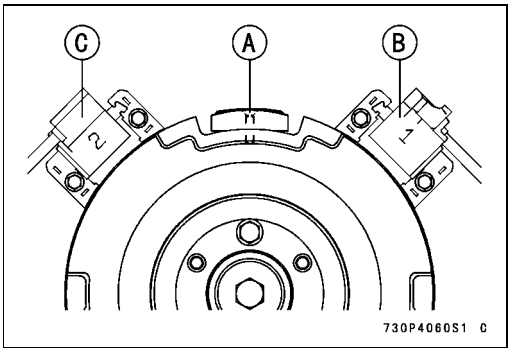
★If the inside diameter is more than the service limit, replace the rocker arm.

Rocker Arm Bearing Inside Diameter
Service Limit: 11.052 mm (0.4351 in)



Valves

Valve Clearance Inspection



NOTE

○ *Valve clearance must be checked when the engine is cold (at room temperature).*

● Remove the rocker case (see Cylinder Head Removal).
● Place the piston at top dead center (TDC) of the compression stroke turning the crankshaft clockwise facing the flywheel.

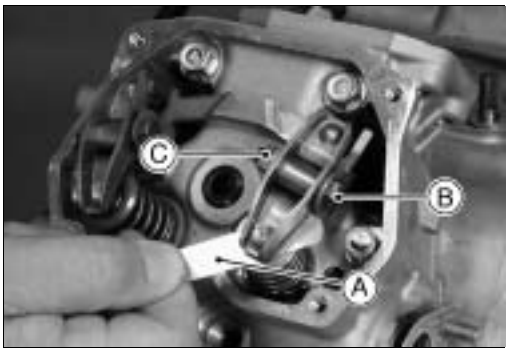
No.1 Cylinder:
○ Align the flywheel magnet [A] with No. 1 ignition coil [B].
○ Check the intake and exhaust valves are closed completely, if it is not at T.D.C, turn the flywheel clockwise one turn (360°).

No.2 Cylinder:
○ Align the flywheel magnet [A] with No. 2 ignition coil [C]. Follow No.1 Cylinder alignment.

● Then check the clearance.
○ Using a thickness gauge [A], measure the valve clearance between the rocker arm and the valve stem end.
★ If the valve clearance is incorrect, adjust it. (see Valve Clearance Adjustment)

Valve Clearance (when cold)
Intake, Exhaust: 0.15 mm (0.006 in)

Valve Clearance Adjustment



● Since the valve repairs change the valve clearance, adjust the valve clearance to the specification.
● Assemble the cylinder head and install the cylinder head assembly on the block (see Cylinder Head Installation).
● Turn the crankshaft proper direction until the piston is at TDC of the compression stroke (described above).
● Loosen the lock nut [C] and valve clearance adjusting bolts [B].
● Insert a 0.15 mm (0.006 in.) thickness gauge [A] between the rocker arm and valve stem, and turn the adjusting bolt until the thickness gauge begin to bind between the rocker arm and valve stem end. Use a sweeping motion with the thickness gauge while making this adjustment.
● Holding the adjusting bolt with a spanner, tighten the locknut to the specified torque.

Torque - Valve Clearance Adjusting Locknuts: 11 N·m (1.1 kg·m, 96 in·lb)

● Do not overtighten.

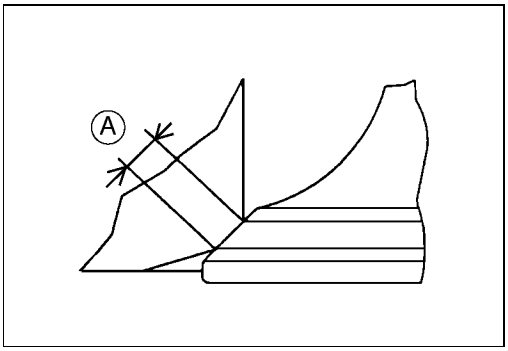
Valves

Valve Seat Inspection

- Remove the valve. (see Valve Mechanism Removal/Installation)
- Inspect the valve seats for damage.

★If the seats are warped or distorted by beyond reconditioning, replace the cylinder head.

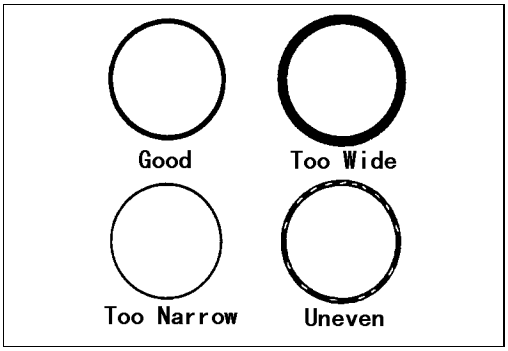
- Pitted or worn valve seats can be refaced. Lap the valves to the seats after refacing.
- Coat the valve seat with machinist's dye.
- Push the valve into the guide.
- Rotate the valve against the seat with a lapping tool.
- Pull the valve out, and check the seating pattern on the valve head. It must be the correct width [A] and even all the way around.



NOTE

○ *The valve stem and guide must be in good condition or this check will not be valid.*

★If the valve seating pattern is not correct, repair the seat.



Valve Seating Surface Width (STD)

Inlet	**0.8 ~ 1.4 mm (0.03 ~ 0.05 in.)**
Exhaust	**1.1 ~ 1.6 mm (0.04 ~ 0.06 in.)**

Valve Seat Repair

- Follow the manufacture's instructions for use of valve seat cutters (special tools).

Special Tools

Intake Valve:		
Seat Cutter	**45° - ø35.0**	**57001-1116**
Outside Cutter	**30°- ø33.0**	**57001-1199**
Exhaust Valve:		
Seat Cutter	**45°- ø30.0**	**57001-1187**
Outside Cutter	**30°- ø30.0**	**57001-1120**

Holder and Bar

Holder - ϕ7.0	**57001-1126**
Bar	**57001-1128**

★If the manufacture's instructions are not available, use the following procedure.

Seat Cutter Operating Cares:

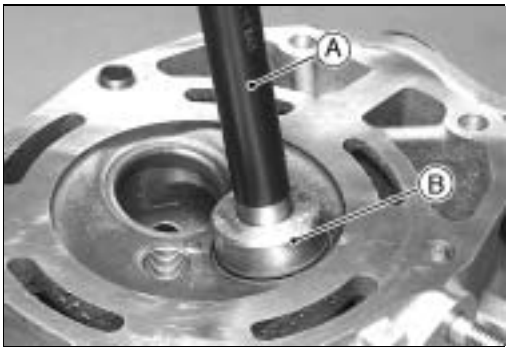
- This valve seat cutter is designed only for valve seat repair. Therefore the cutter must not be used for other purposes.
- Do not drop or hit the valve seat cutter, or the diamond particles may fall off.
- Do not fail to apply engine oil to the valve seat cutter before grinding the seat surface. Also wash off ground particles sticking to the cutter with washing oil.

NOTE

○ *Do not use a wire brush to remove the metal particles from the cutter. It will take off the diamond particles.*

Valves

● Setting the valve seat cutter holder [A] in position, operate the cutter [B] with one hand. Do not apply too much force to the diamond portion.



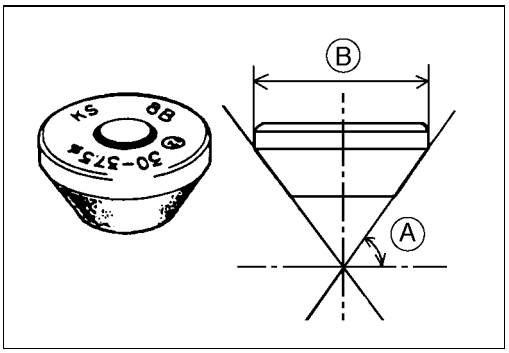
NOTE

○ *Prior to grinding, apply oil to the cutter, and during the operation wash off any ground particles sticking to the cutter with washing oil.*

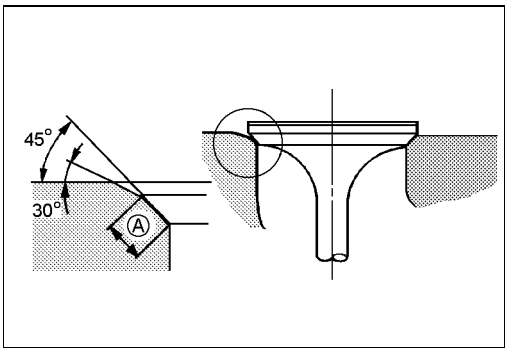
● After use wash the cutter with washing oil and apply a thin layer of engine oil before storing.

Marks Stamped on the Cutter:
The marks stamped on the back of the cutter represent the following.

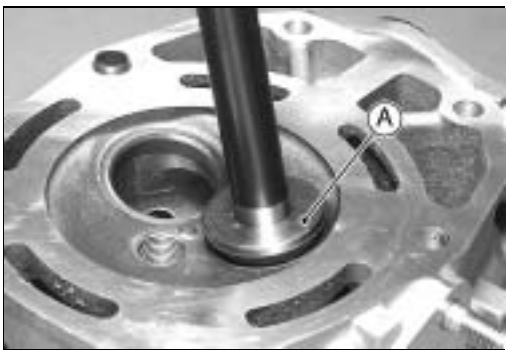
1	Cutter number, selected from 1 to 12
30°	Cutter angle [A]
37.5	Outer diameter of cutter [B]
KS8B	Manufactured lot number



Operating Procedures:
● Clean the seat area carefully.
● Recondition the valve seats with the valve seat cutters (45°, 30°) and lap the valves.
● Check the seats for good contact all the way around with machinist's dye.
● Measure the seat width [A]. If it is more than the STD width, the seating surface should be refaced.
★ If the valve seating pattern is not correct, repair the seat.



● Coat the seat with machinist's dye.
● Fit a 45° cutter [A] to the holder and slide it into the valve guide.
○ Resurface the valve seat with a 45° cutter, removing only enough material to produce a smooth and concentric seat.



CAUTION

Do not grind the seat too much. Overgrinding will reduce valve clearance by sinking the valve into the head. If the valve sinks too far into the head, it will be impossible to adjust the clearance, and the cylinder head must be replaced. Do not turn the cutter counterclockwise or drop it against the seat, or it will be dulled.

Valves

● Use a 30° seat cutter [A] to narrow the seat width to the STD width.
○ Turn the seat cutter one turn at a time while pressing down very lightly. Check the seat width after each turn.

CAUTION

The 30° cutter removes material very quickly. Check the seat width frequently to prevent over grinding.

NOTE

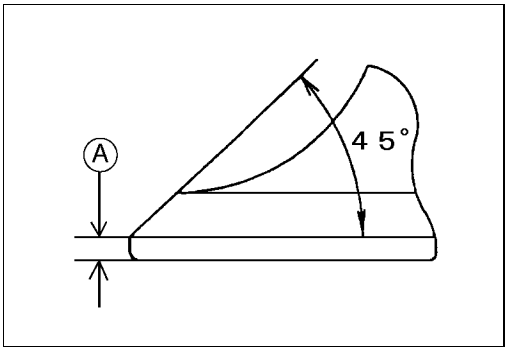
○ *Keep the seat width as closely as possible to the STD width.*

● Make a light pass with the 45° cutter to remove any possible burrs at the edge of the seat.
● After resurfacing the seat, inspect for even valve seating.
○ Apply a machinist's dye to the valve face, insert the valve, and snap it closed against the seat several times. The valve surface should show good contact all the way around. Be sure the valve seat is centered on the valve face. The position of the valve in the seat is evident after lapping the valve.
★ If the seat does not make proper contact, lap the valve into seat with a vacuum cap tool [A].

● Coat the face of valve sparingly with a fine lapping compound.
● Use the vacuum cup tool, to grip top of the valve. Rotate the valve in a circular motion to lap the valve to the seat.
● Lift the valve slightly from the seat every 8 to 10 strokes, continue lapping operation until a uniform ring appears around entire surface of the valve face.
● When lapping is completed, wash all parts in solvent to remove lapping compound. Dry the parts thoroughly.
● Note the position of the lapping mark on the valve face. The lapping mark should appear on or near the center of the valve face.
● When the engine is assembled, be sure to adjust the valve clearances. (see Valve Clearance Adjustment)

Valve Head Thickness

● Remove the valve (see Valve Mechanism Removal/Installation).
● Measure the thickness of the valve head.
★ If the valve head thickness (valve margin) [A] is less than the service limit, replace the valve.



Valve Head Thickness
Service Limit (IN, EX): 0.6 mm (0.024 in)

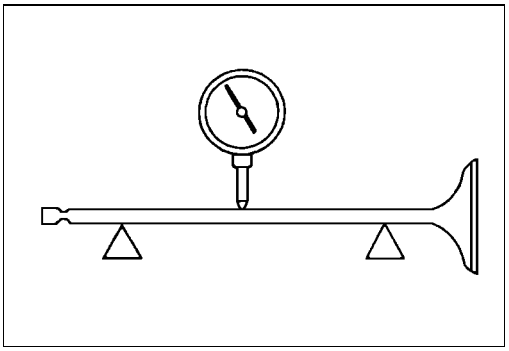
Valves

Valve Stem Runout

- Support the valve in V blocks at each end of the stem.
- Position a dial gauge perpendicular to the stem.
- Turn the valve and read the variation on the dial gauge.

★If the stem runout is greater than service limit, replace the valve.

Valve Stem Runout
Service Limit (IN, EX): 0.05 mm (0.002 in.)

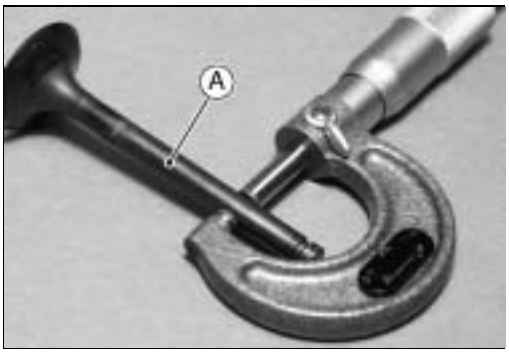


Valve Stem Diameter

- Measure the diameter of the valve stem [A] in two directions at right angles, at four different positions on the stem.

★If any single measurement is less than the service limit, replace the valve.

Valve Stem Diameter
Service Limit:
Intake, Exhaust: 6.935 mm (0.2730 in.)

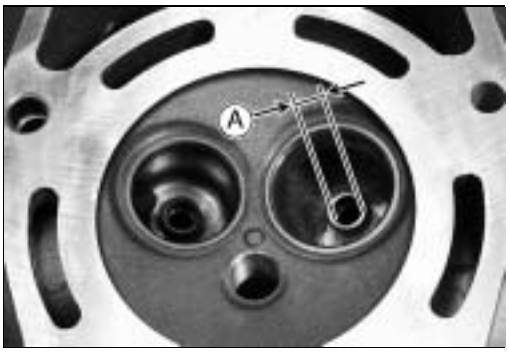


Valve Guide Inside Diameter

- Use a small bore gauge or a micrometer to measure the inside diameter [A] of the valve guide a three places down the length of the guide.

★If the measurement is more than the service limit, replace the cylinder head with a new one.

Valve Guide Inside Diameter
Service Limit:
Intake, Exhaust: 7.080 mm (0.2787 in.)

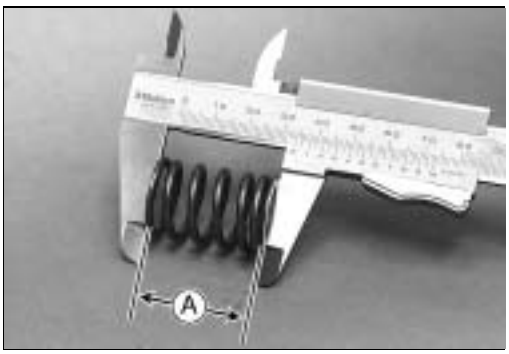


Valve Spring Inspection

- Inspect the valve spring for pitting, cracks, rusting, and burrs. Replace the spring if necessary.
- Measure the free length [A] of the spring.

★If the measurement is less than the service limit, replace the spring.

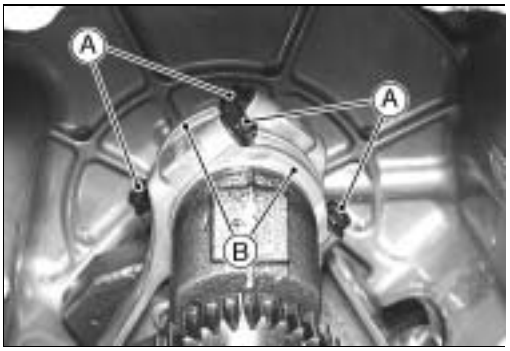
Valve Spring Free Length
Service Limit: 31.00 mm (1.22 in.)



Cylinder, Piston

Piston Removal

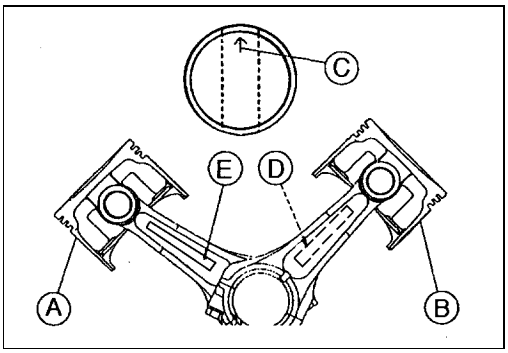
- Split the crankcase (see Camshaft/Crankshaft chapter).
- Remove the camshaft (see Camshaft/Crankshaft chapter).
- Turn the crankshaft to expose the connecting rod cap bolts [A].
- Remove the bolts and take off the connecting rod caps [B].



NOTE

○ *Note the position of the connecting rod caps for reinstalling the caps.*

- Push the connecting rod end into the cylinder, and pull the piston and connecting rod out of the cylinder.

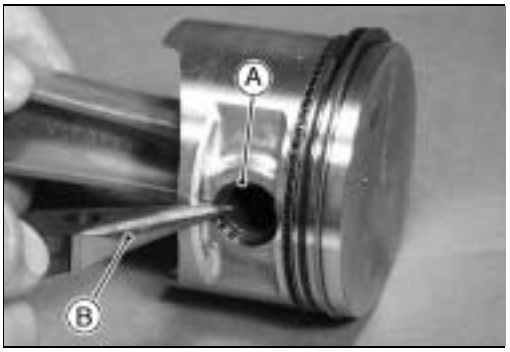


CAUTION

Note a location of the arrow match mark on the piston head in relation to MADE IN JAPAN on the connecting rod. No.1 cyl. piston is opposite of No.2 cyl. piston. Keep parts together as a set.

[A] No.1 Cyl. Piston
[B] No.2 Cyl. Piston
[C] Arrow Match marks
[D] MADE IN JAPAN
[E] Opposite MADE IN JAPAN

- Remove one of the piston pin snap rings [A] with needle nose pliers [B].

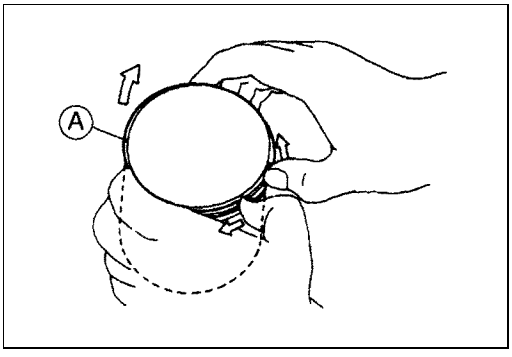


- Remove the piston by pushing the piston pin [A] out the side from which the snap ring was removed.

- Remove the top and second rings with piston ring pliers.

Special Tool - Piston Ring Pliers: 57001–115

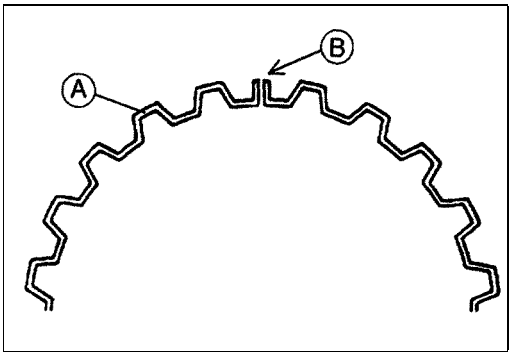
- If the special too is not available, carefully spread the ring opening with your thumbs and then push up on the opposite side of the ring [A] to remove it.
- Remove the 3-piece oil ring with your thumbs in the same manner.



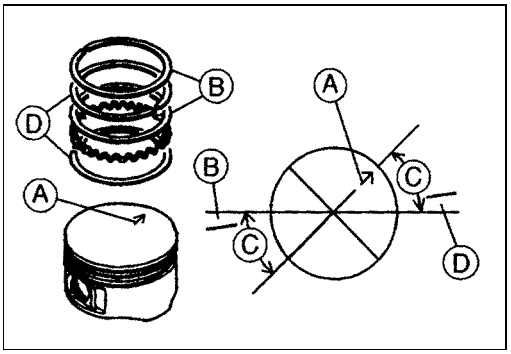
Cylinder, Piston

Piston Installation

- Install the expander [A] in the piston oil ring groove so that the expander ends [B] touch together, never overlap.
- Install the upper and lower steel rails. There is no UP or Down to the rails. They can be installed either way.



- Install the chrome-plated top ring and second ring with “R” mark facing up. The rings should turn freely in the grooves.
- Align the piston and rings with the piston ring end gap as shown.
  [A] Arrow Match Marks
  [B] Top Ring End Gap, Upper Steel Rail End Gap
  [C] 30° ~ 45°
  [D] Second Ring End Gap, Lower Steel Rail End Gap

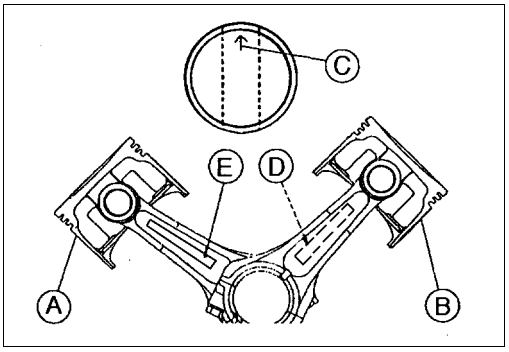


- Apply engine oil to the piston pins.
- Assemble the pistons onto the connecting rods as follow:

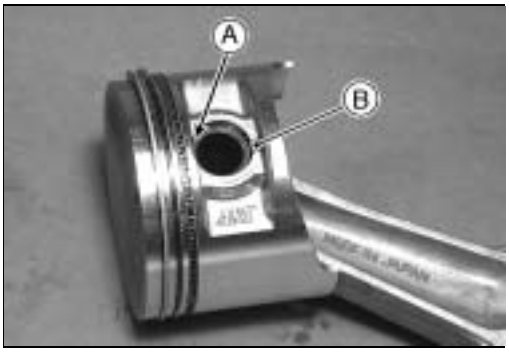
No.1 Cyl. piston, align the arrow match mark on the piston head with the raised letters (MADE IN JAPAN) on the connecting rod.

No.2 Cyl. piston, align the arrow match mark on the piston head with opposite MADE IN JAPAN on the connecting rod.

[A] No.1 Cyl. Piston
[B] No.2 Cyl. Piston
[C] Arrow Match Marks
[D] MADE IN JAPAN
[E] Opposite MADE IN JAPAN



- When installing a piston pin snap ring, compress it only enough to install it and no more.
- Fit a new piston pin snap ring into the side of the piston so that the ring opening [A] does not coincide with the notch [B] in the edge of the piston pin hole.



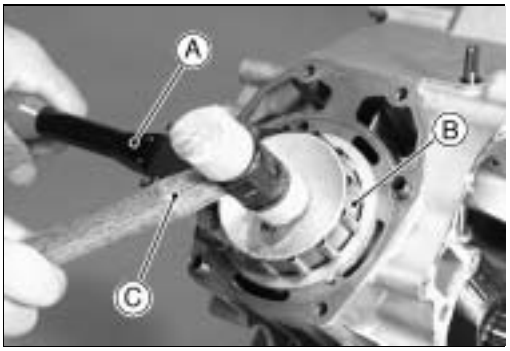
CAUTION
Do not reuse the snap rings, as removal weakens and deforms them. They could fall out and score the cylinder wall.

- Install the piston and connecting rod so that the arrow match mark [A] on the top of the piston facing the flywheel side [B].

★Apply engine oil to the piston skirt and the cylinder bore.

Cylinder, Piston

○ Using the piston ring compressor grip [A] and the belt [B], insert the piston and connecting rod into the cylinder.
○ Lightly tap the top of the piston with a plastic mallet [C] to insert the piston and connecting rod into the cylinder.



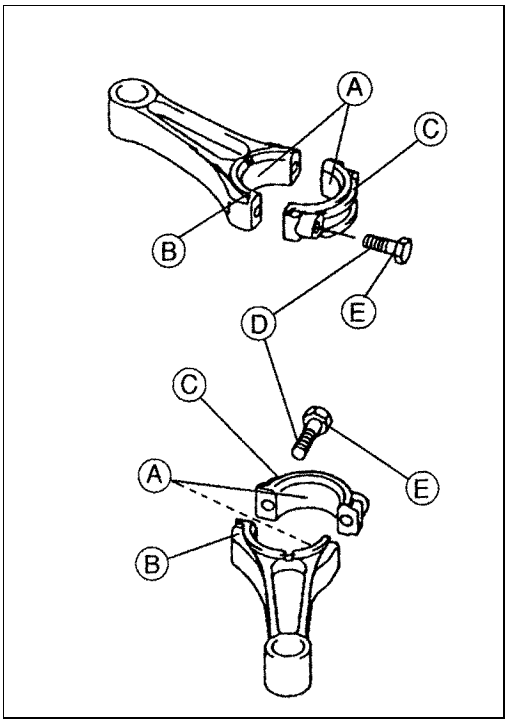
CAUTION

The connecting rod and the connecting rod big end cap are machined at the factory in the assembled state, so they must be replaced together as a set.

● Apply engine oil to the inner surface [A] of the connecting rod big end [B] and caps [C].
● Install the connecting rod big end caps on their original position on each connecting rod big ends.
● Apply a small amount of engine oil to the thread [D] and seating surface [E] of the cap bolts.
● Tighten the cap bolts.

Torque - Connecting Rod Big End Cap Bolts: 21 N·m (2.1 kg·m, 15 ft·lb)

● Install:
Camshaft (see Camshaft/Crankshaft chapter)
Crankcase Cover (see Camshaft/Crankshaft chapter)



Piston/Cylinder Seizure
● In case of seizure, remove the piston.
● Visually inspect the cylinder and piston damage.
★If there is only light damage, smooth the position with #400 emery cloth. Remove the small aluminum deposits from the cylinder with #400 emery cloth or light honing.
★If the damage is severe, the both cylinders must be bored oversize and an oversized pistons installed.

Cylinder, Piston

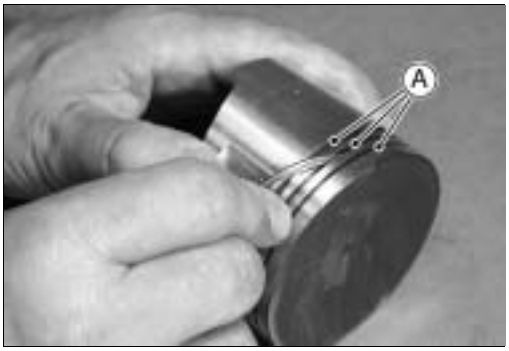
Piston Cleaning

● Remove the piston and piston rings (see Piston and Ring Removal).

CAUTION

Never clean the piston head with the engine assembled. Carbon particles will fall between the piston and cylinder, and damage the crankshaft bearings.

● Scrape the carbon off [A] the piston head.
● Use the scraping tools carefully. Do not gouge the piston head. To avoid gouging, use scrapers that are made of a material that will not cause damage.
● Clean the piston ring grooves [A] with a broken piston ring or other suitable tools.



CAUTION

Be careful not to widen the ring grooves. Damaged ring grooves will require piston replacement.

Piston Ring and Ring Groove Wear

● Clean the piston (see Piston Cleaning).
● Visually inspect the piston rings and ring grooves.
★ If the piston rings are worn unevenly or damaged, replace them.
★ If the ring grooves are worn unevenly or damaged, replace both the piston and piston rings.
● Check ring grooves for wear by inserting a new ring in the proper groove at several points around the piston.
● Measure the clearance between the top and second rings and their grooves using a thickness gauge [A].

★ If the piston ring/groove clearance is greater than the specified value, replace the piston.

Piston Ring/Groove Clearance

	Service Limit
Top, Second	0.15 mm (0.006 in.)

NOTE

○ *The oil ring is a three piece assembled ring. Difficult to measure the ring groove clearance and thickness, visually inspect only.*

● Measure the piston ring thickness.
○ Use a micrometer to measure at several points around the rings.
★ If any of the measurement are less than the service limit, replace the entire set of rings.

Piston Ring Thickness

	Service Limit
Top, Second	1.40 mm (0.055 in.)

NOTE

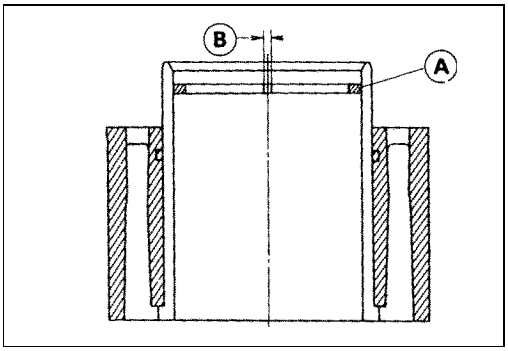
○ *When using new rings in a used piston, check for uneven groove wear. The rings should fit perfectly parallel to the groove sides. If not, replace the piston.*

Cylinder, Piston

Piston Ring End Gap

- Remove the piston rings.
- Push each ring (one at a time) in the cylinder bore to a point close to the bottom of the cylinder bore.
- Use the piston to push it in to be sure it is square.
- Measure the gap [B] between the ends of the ring [A] with a thickness gauge.

★If the end gap of any ring is greater than the service limit, replace the entire set of rings.



Piston Ring End Gap

	Service Limit
Top,Second	1.0 mm (0.04 in.)
Oil	1.2 mm (0.05 in.)

Piston Pin, Piston Pin Hole, and Connecting Rod Wear

- Remove the piston pin.
- Measure the diameter of the piston pin with a micrometer at several points.

★If the outside diameter is less than service limit, replace the piston pin.

Piston Pin Outside Diameter
Service Limit: 18.960 mm (0.7465 in.)

- Measure the inside diameter [A] of the piston pin hole at several points on both side. Use a dial bore gauge.

★If the inside diameter is more than the service limit, replace the piston.

Piston Pin Hole Inside Diameter
Service Limit: 19.080 mm (0.7512 in.)

- Measure the inside diameter [A] of the small end of the connecting rod at several points. Use a dial bore gauge.

★If the inside diameter is more than the service limit, replace the connecting rod.

Connecting Rod Small End Inside Diameter
Service Limit: 19.060 mm (0.7504 in.)

Cylinder, Piston

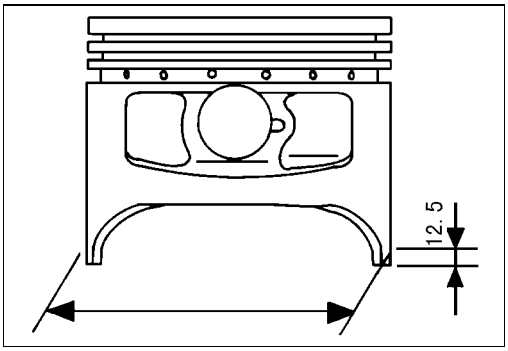
Piston Diameter

● Measure the outside diameter of the piston 11 mm (0.43 in.) up from the bottom of the piston at a right angle to the direction of the piston pin hole.

★If the measurement is less than the service limit, replace the piston.

Piston Outside Diameter

Service Limit:	**77.700 mm (3.0590 in.)**

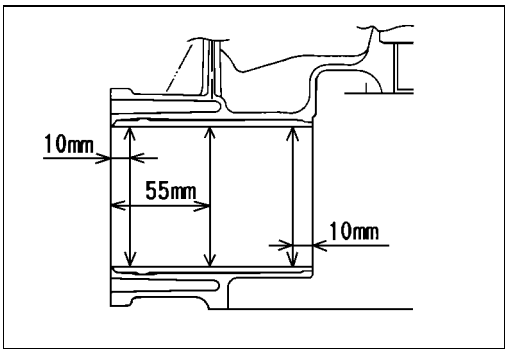


Cylinder Inside Diameter

● Clean and measure the cylinder inside diameter.

○ Use a dial bore gauge to measure front-to-back and side-to-side at the points shown below.

★If any of the cylinder bore measurements is greater than the service limit, the cylinder must be bored to the next oversize and then honed (see Cylinder Boring and Honing).



Cylinder Inside Diameter

Cylinder Inside Diameter:

Standard:	**78.000 mm (3.0709 in.)**
Service Limit:	**78.080 mm (3.0740 in.)**
0.5 mm Oversize:	**78.500 mm (3.0905 in.)**
Service Limit:	**78.580 mm (3.0937 in.)**

Cylinder Bore Out-of-Round

Service Limit	**0.056 mm (0.0022 in.)**

Cylinder Boring and Honing

Always resize to exactly 0.5 mm (0.02 in.) over the standard bore size.

If this is done accurately, the stock oversize rings and piston will fit perfectly and proper clearance will be maintained.

Resizing the cylinder bore can be done by reliable repair shop or by using a drill press and honing tool.

Use the stone recommended by the hone manufactures to produce correct cylinder wall finish.

Machine-bore first, the bore diameters should be shown in the table.

Fine Boring Bore Diameter

Oversize	Bore Diameter
0.50 mm	**78.480 to 78.460 mm (3.0898 to 3.0890 in.)**

Cylinder, Piston

Change to a honing stone for finishing, the final bore diameter should be as shown in the table.
Be sure the correct stone is used and the stone is not worn.

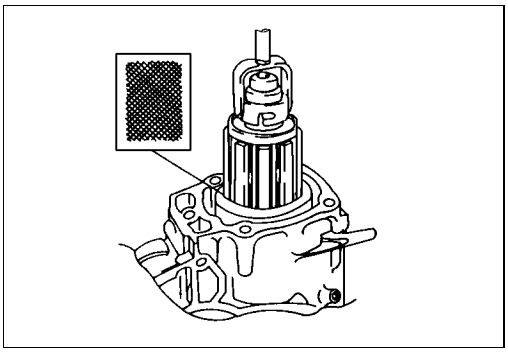
- Clean the cylinder at the top and bottom of the cylinder to remove burrs and pieces of the base and head gasket.
- Anchor the cylinder (block) on the drill press table before honing.
- Align the center of the cylinder bore to the press center. Set the press to operate from 200 to 250 rpm.
- Connect the drive shaft to the hone and set the stop on the drill press so the hone can only extend 20 to 25 mm (3/4 to 1.0 in.) above the top or below the bottom of the cylinder liner.
- Rotate the adjusting nut (knob) on the hone until the stones contact snugly against the cylinder wall at the narrowest point. “Do not Force”.
- Turn the stone by hand. If you cannot turn it, the stone is too tight. Loosen the hone until it can be turned by hand.
- Be sure that the cylinder and hone are centered and aligned with the drive shaft and drill spindle.
- Pour honing oil inside of the cylinder during the honing operation. Start the drill press. Move the hone up and down in the cylinder approximately 20 cycles-per-minute.
- Check the diameter of the cylinder bore regularly during honing, using an inside micrometer.

Fine Bore Diameter

Oversize	Bore Diameter
0.50 mm	78.500 to 78.480 mm (3.0905 to 3.0898 in.)

CAUTION

Stop the drill press before measuring and remove the hone from the cylinder.



NOTE

- *The finish should not be smooth, but have a 40 to 60 degree crosshatch pattern.*

- Hone the cylinder until it is about 0.007 to 0.009 mm (0.0003 to 0.0004 in) large to allow for shrinkage when the cylinder cools.

NOTE

- *Do not use gasoline, kerosene, or commercial solvent to clean the cylinder bore. These fluids only wash all the oil from the cylinder wall. They do not remove the metal particles produced during honing.*

- Clean the cylinder thoroughly. Use soap warm water and clean rags. Clean the cylinder wall for “white glove” inspection. A clean white rag should not show soil from the cylinder wall.
- Dry the cylinder and coat with a engine oil.

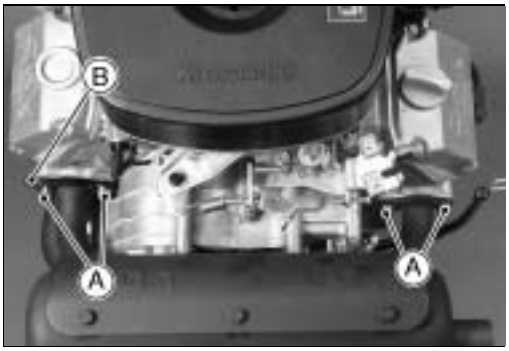
CAUTION

The cylinder must be thoroughly cleaned after honing to eliminate all grit.

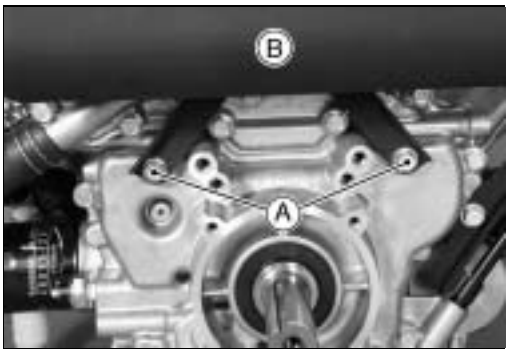
Muffler

Muffler Assembly Removal

- Unscrew the flange nuts [A], and remove the spring washers and engine hook [B] (Only No.1 Cylinder side). Use a penetrating oil if necessary to break threads loose.



- Remove the bolts [A] on the muffler bracket and take off the muffler assembly [B].
- Remove the gaskets.
- Do not use unnecessary force on the exhaust pipes when removing the muffler assembly, or they could become damaged or distored.



Muffler Assembly Installation

- Clean the exhaust pipe flanges to the exhaust port gasket surfaces and install a new gaskets each time the muffler installed.
- Install the gasket.
- Install the muffler, engine hook, spring washers and nuts.
- To prevent mis-threading, finger tight the flange nuts first. Next tighten the bolts on the muffler bracket.
- Tighten the nuts and bolts.

Torque - Exhaust Pipe Flange Nuts: 20 N·m (2.0 kg·m, 15 ft·lb)

- After installation, thoroughly warm up the engine, wait until the engine cools down and retighten the bolts and nuts.

Inspection

- Inspect the exhaust pipe or muffler for dents, cracks, rust and holes.

★If the exhaust pipe or muffler is damaged, it should be replaced for best performance and least noise.

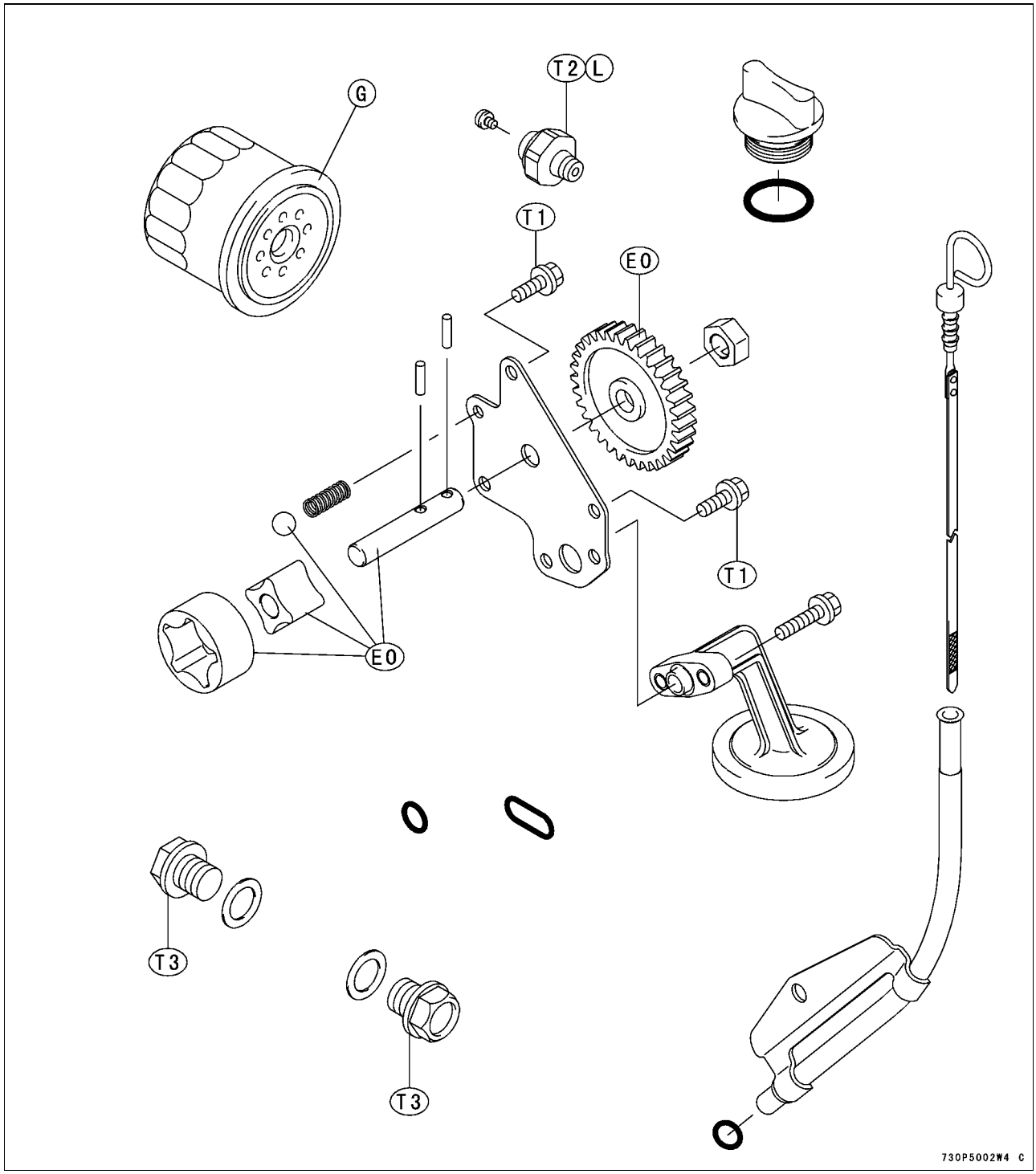
- Check the muffler for distortion and/or loose internal components. Loss of power could develop if the muffler loose the internal components restricting the exhaust flow.
- Check for breaks in the seams and check weld at the junction of the exhaust pipes and muffler.
- Tap the muffler with a plastic hammer to decarbonize.

Lubrication System

Table of Contents

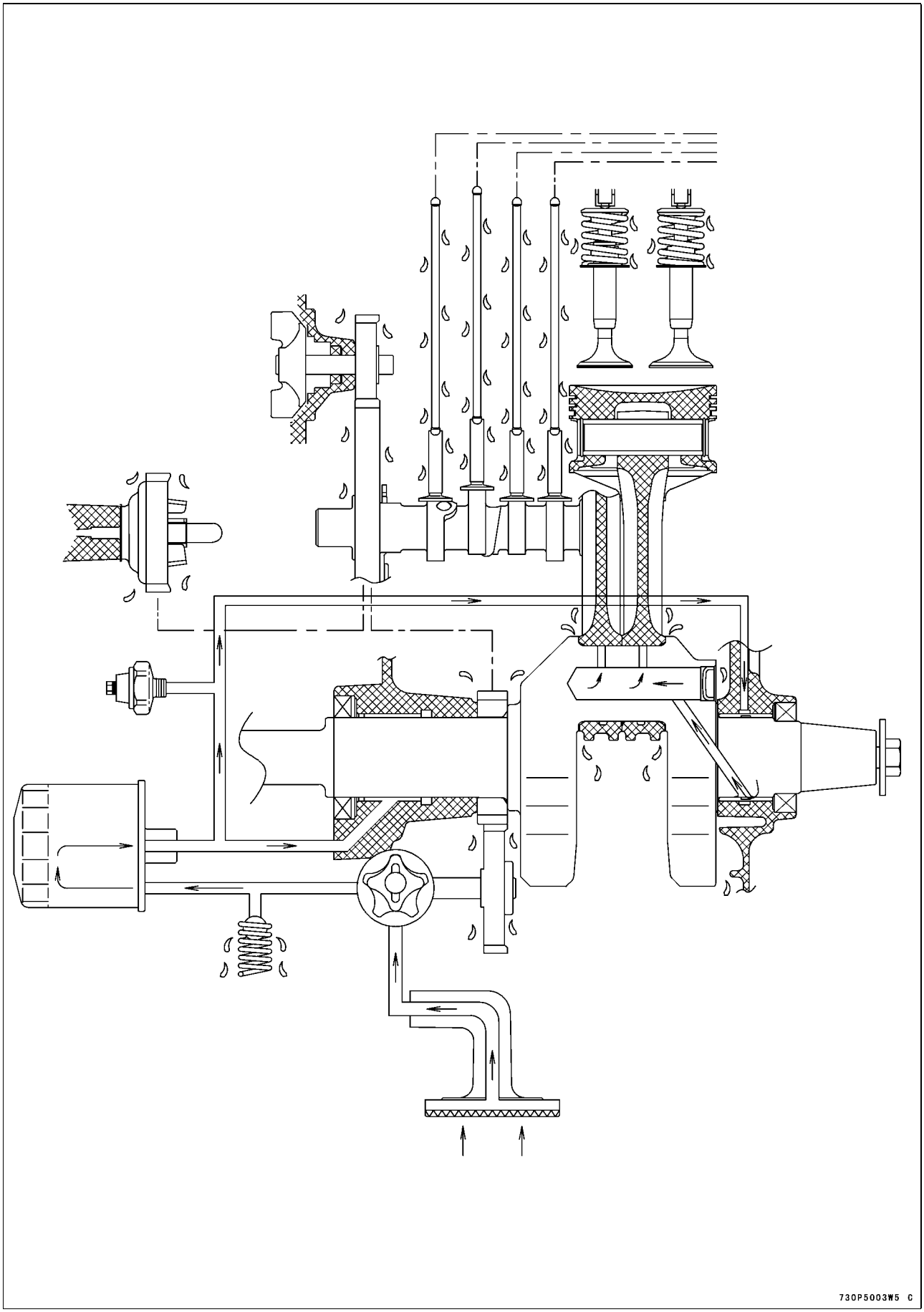
Exploded View....5-2
Engine Oil Flow Chart....5-3
Specifications....5-4
Engine Oil and Oil Filter....5-5
Oil Level Inspection....5-5
Oil Change....5-5
Oil Filter Removal....5-6
Oil Filter Installation....5-6
Pressurized Lubrication System....5-7
Oil Pressure Measurement....5-7
Oil Pressure Switch Inspection....5-7
Oil Pump and Relief Valve....5-8
Oil Pump, Relief Valve Removal....5-8
Oil Pump, Relief Valve Installation....5-8
Oil Pump, Relief Valve Inspection....5-8
Oil Screen Filter....5-11
Removal....5-11
Cleaning and Inspection....5-11

Exploded View



EO: Apply engine oil.
G: Apply grease.
L: Apply a non-permanent locking agent.
T1: 6 N·m (0.6 kg·m, 52 in·lb)
T2: 15 N·m (1.5 kg·m, 11 ft·lb)
T3: 25 N·m (2.5 kg·m, 18 ft·lb)

Engine Oil Flow Chart



5-4 LUBRICATION SYSTEM

Specifications

Item	Standard
Engine Oil:	
Grade	API service classification; SF, SG, SH, or SJ class
Viscosity	SAE40, SAE30, SAE10W-30 / SAE10W-40, or SAE5W-20 (see Oil Change)
Capacity	1.8 L (1.9 US qt) [When filter is not removed] 2.0 L (2.1 US qt) [When filter is removed]
Level	Between upper [H] and lower [L] level line
Oil Pressure (MIN)	276 kPa (40 psi)
Oil Pressure Switch:	
Detect pressure	98 kPa (14.2 psi)
Screw	PT 1/8 pipe thread
Oil Filter By-pass Valve Openning	
Pressure	78.5 to 117.5 kPa (11.4 to 17.1 psi)

Item	Service Limit
Oil Pump:	
Inner and outer rotor clearance	0.3 mm (0.012 in.)
Outer rotor outside diameter	40.470 mm (1.5933 in.)
Outer rotor thickness	19.830 mm (0.7807 in.)
Pump housing inside diameter	40.801 mm (1.606 in.)
Pump housing depth	20.230 mm (0.7965 in.)
Pump shaft outside diameter	10.923 mm (0.4300 in.)
Relief valve spring free length	19.50 mm (0.77 in.)
Pump shaft bearing inside diameter	11.072 mm (0.4359 in.)

Engine Oil and Oil Filter

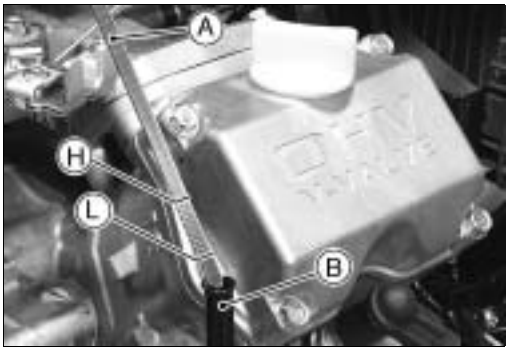
CAUTION

Engine operation with insufficient, deteriorated, or contaminated engine oil will cause accelerated wear and may result in engine seizure and accident.

Oil Level Inspection

- Place the engine on a level surface and check the oil level.
- Clean area around the oil gauge [A] before removing it.
- Remove the oil gauge and wipe it with a clean cloth.
- Insert the oil gauge into tube [B] following the tube bend and let it's plug firmly fit into the tube, then check the oil level.
- The oil level should be between the "H" [H] and "L" [L] marks on the oil gauge.

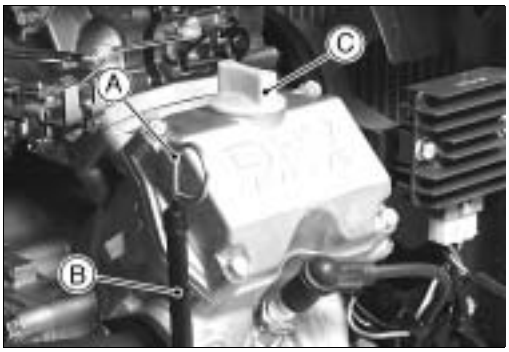
★If the oil level is near or below the "L" mark, remove the oil filler cap [C] and add enough engine oil to bring oil level to the "H" mark.



CAUTION

Do not fill above the "H" mark. Excess oil will cause a smoking condition, and may cause the engine to overheat.

★If the oil level is too high, remove the excess oil by loosening the drain plug [D].



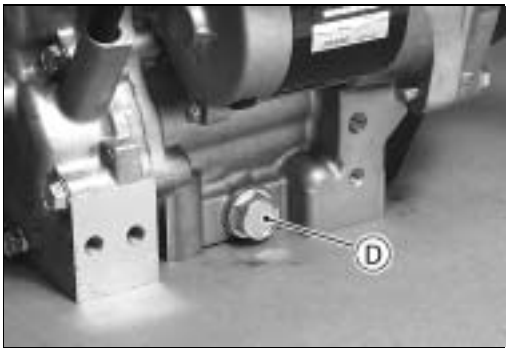
CAUTION

Before starting the engine for the first time, add oil: The engine is shipped dry. Preoil the engine to force all air from the internal oil passages and the oil filter.

- Fill fresh engine oil to the specified level.
- Run the engine at slow speed 2 minutes.
- Stop the engine and check the oil level.
- Add oil only to the "H" mark on the oil gauge. Use the same type and make of oil that is already in the engine.

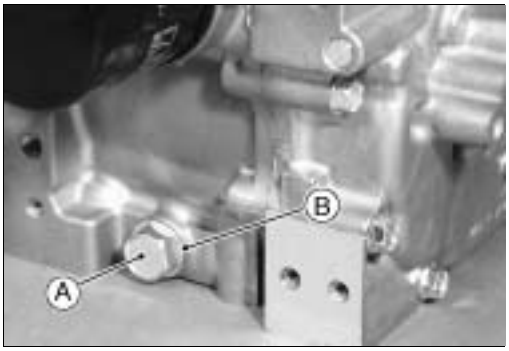
NOTE

○ *If the engine oil type and make are unknown, use any brand of the specified oil to top up the level in preference to running the engine with the oil level low. Then at your earliest convenience, change the oil completely.*



Oil Change

- Change oil after first 8 hours of operation. Thereafter change oil every 100 hours.
- Start and warm up the engine so the oil will drain easily. Stop the engine.
- Place the engine on a level surface.
- Place a suitable container under the engine.
- Remove the drain plug [A] and drain the oil.



⚠WARNING

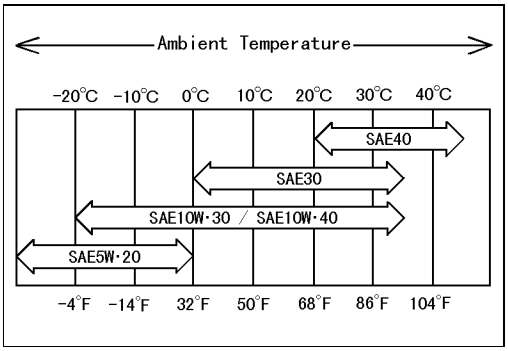
Be careful with not oil being drained. If may be hot enough to burn you severely.

- Check the gasket [B] at the drain plug for damage. Replace the gasket with a new one if it is damaged.
- Install the drain plug with the gasket and tighten it.

Torque - Oil Drain Plug: 25 N·m (2.5 kg·m, 18 ft·lb)

Engine Oil and Oil Filter

● Remove the oil filler cap and pour in the specified type and amount of oil.



Engine Oil :

Grade:	**API Service Classification; SF, SG, SH, or SJ Class**
Viscosity:	**SAE40, SAE30, SAE10W-30/SAE10W-40, or SAE5W-20**
Capacity:	**1.8 L (1.9 US qt) [When filter is not removed]**
	2.0 L (2.1 US qt) [When filter is removed]
Level:	**Between Upper [H] and Lower [L] level line.**

NOTE

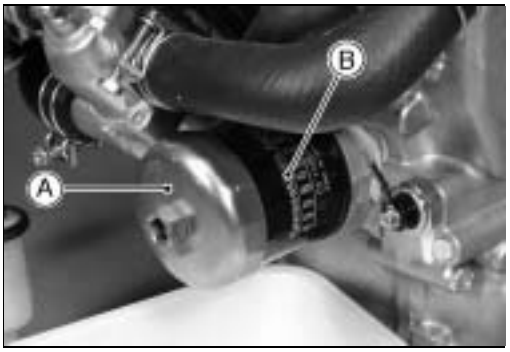
○ *Some increase in oil consumption may be expected when a multi grade engine oil (10W-30/10W-40, 5W-20) is used. Check the oil level frequently.*

Oil Filter Removal

● Using a strap wrench or oil filter wrench [A], remove the oil filter [B].

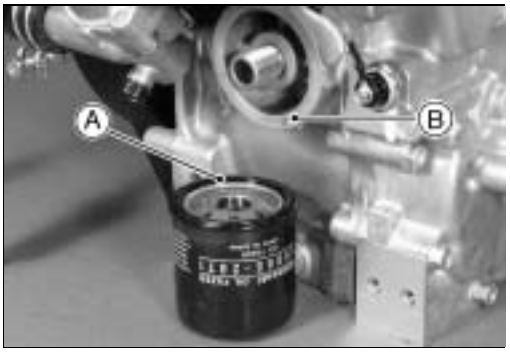
Special Tool - Oil Filter Wrench: 57001–1249

○ When unscrewing the oil filter, place a suitable container beneath the oil filter to receive oil from the oil filter and oil passages in the engine. Turn the filter counterclockwise to remove it



Oil Filter Installation

● Apply a thin coat of grease to the seal [A].
● Install a new filter.
○ Turn the filter until the seal contacts mounting surface [B] of the engine. Then turn the filter BY HAND(S) 3/4 turn more.
● Run the engine at slow idle speed 2 minutes. Check for leaks around the engine.
● Stop the engine. Check the oil level (see Oil Level Inspection).



Pressurized Lubrication System

The engine lubrication circuit is a pressurized system consisting of a positive displacement pump which picks up oil through a filter screen from the crankcase. The oil is pumped to a replaceable oil filter cartridge, through the engine's oil passages to lubricate internal components, and return to the crankcase. A bypass valve is incorporated in the oil filter to allow oil to circulate if the filter becomes clogged. A pressure relief valve is used between the oil pump and oil filter to relieve excessive oil pressure by returning excess oil to the crankcase (see Oil Flow Chart).

Oil Pressure Measurement

- Remove the oil pressure switch [A] from the crankcase.
- Install an appropriately sized oil pressure gauge adapter [B] and oil pressure gauge [C].
- Run the engine and allow warm up completely.
- Run the engine at fast idle speed and read the oil pressure gauge.
- Stop the engine.
- Remove the oil pressure gauge and adapter.
- Apply silicone sealant to the taper threads of the pressure switch and install the switch.

Sealant - Kawasaki Bond (Silicone Sealant) : 56019–120

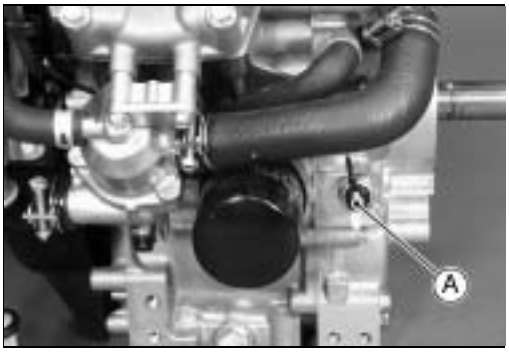
Torque - Oil Pressure Switch : 15 N·m (1.5 kg·m, 11 ft·lb)

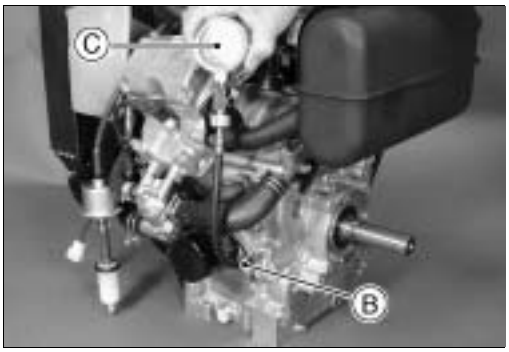
★If the oil pressure is below the specification, inspect the oil pump and relief valve.

★If the oil pump and relief valve are not at fault, inspect the rest of the lubrication system.

Oil Pressure (Minimum)
276 kPa (40 psi)

Oil Pressure Switch
PT 1/8 (Taper Pipe Threads)





Oil Pressure Switch Inspection

When the oil pressure falls below 98 kPa (14.2 psi), the oil pressure switch activates the oil warning lamp to alert the operator or lubricating problem.

- To check the oil warning system, insert the switch key into the "OFF" position of the engine switch, then turn it to the "RUN" position. The warning light must be illuminated.
- Whenever start the engine, make sure the warning light is not on in started engine.

★If the warning light comes on, stop the engine immediately and check the oil level.

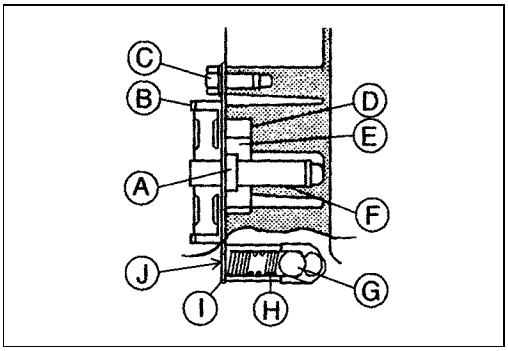
- When starting the engine, note the warning light on dash carefully.

★If the warning light is on in the started engine in spite of adequate oil level, check the lead from the pressure switch to the warning light for short circuit and/or check the pressure switch and replace damaged part.

★If the light is not on at the moment of the engine switch operation, check all leads of the warning light circuit or bulb and replace damaged parts.

Oil Pump and Relief Valve

Oil Pump, Relief Valve Removal



- Remove the crankcase cover (see Camshaft/Crankshaft chapter).
- Unscrew the mounting bolts and remove the oil pump parts assembly (pump gear, pump cover plate, pump shaft, pins and rotors).
- Take off the relief valve spring and ball.
- Disassemble the pump parts assembly.

[A] Pin
[B] Pump Gear
[C] Mounting Bolts
[D] Outer Rotor
[E] Inner Rotor
[F] Pump Shaft
[G] Relief Valve Ball
[H] Spring
[I] Pump Cover Plate
[J] 6 mm DIA Hole

Oil Pump, Relief Valve Installation

- Fill the rotor housing with engine oil for initial lubrication.
- Install the relief valve ball and spring in position, then install the pump parts assembly in the crankcase cover.

NOTE

○ *When installing the pump parts assembly, align the 6 mm DIA hole [A] on the cover plate with center of the relief valve.*

- Install the mounting bolts and tighten them.

Torque - Oil Pump Cover Plate Mounting Bolts : 6 N·m (0.6 kg·m, 52 in·lb)

Oil Pump, Relief Valve Inspection

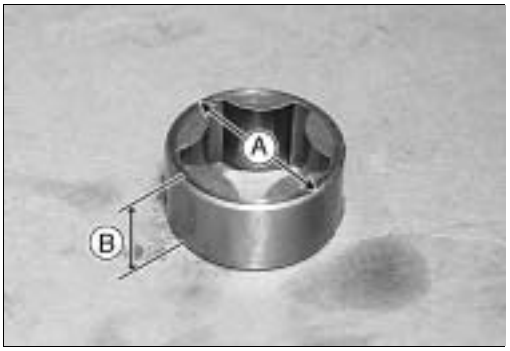
- Remove the oil pump (see Oil Pump, Relief Valve Removal).
- Visually inspect the pump gear, outer and inner rotor, and cover plate.

★If there is any damage or uneven wear, replace them.

○ Check the clearance [A] between the inner and outer rotor with a feeler gauge. Measure the clearance between the high point of the inner rotor and the high point of the outer rotor.

★If the measurement exceed the service limit, replace the rotors as a set.

Inner and Outer Rotor Clearance
Service Limit: 0.3 mm (0.012 in.)



- Measure the outside diameter [A] of the outer rotor with a micrometer at several points.

★If the rotor diameter is less than the service limit, replace both the inner and outer rotor.

Outer Rotor Outside Diameter
Service Limit: 40.470 mm (1.5933 in.)

- Measure the thickness [B] of the outer rotor with a micrometer at several points

★If the rotor thickness is less than the service limit, replace both the inner and outer rotor.

Outer Rotor Thickness
Service Limit: 19.830 mm (0.7807 in.)

Oil Pump and Relief Valve

- Measure the inside diameter [A] of the pump housing with a inside micrometer at several points.

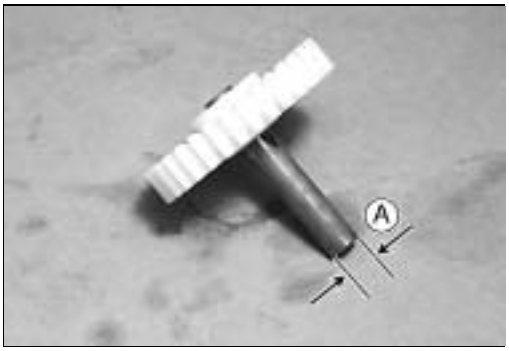
★If the inside diameter is more than the service limit, replace the crankcase cover.

Pump Housing Inside Diameter
Service Limit: 40.801 mm (1.6063 in.)

- Measure the depth [B] of the pump housing with a depth micrometer at several points.

★If any of measurement is more than the service limit, replace the crankcase cover.

Pump Housing Depth
Service Limit: 20.230 mm (0.7965 in.)



- Measure the outside [A] diameter of the pump shaft with a micrometer at several points.

★If the diameter is less than the service limit, replace the pump shaft.

Pump Shaft Outside Diameter
Service Limit: 10.923 mm (0.4300 in.)

- Measurer the inside diameter [A] of the pump shaft bearing in the crankcase cover with a inside micrometer at several points.

★If the inside diameter is more than the service limit replace the crankcase cover.

Inside Diameter of Pump Shaft Bearing
Service Limit: 11.072 mm (0.4359 in.)

- Visually inspect the relief valve spring, steel ball and valve seat in the crankcase cover.

★If any rough spots are found during above inspection, wash the valve clean with a high flash-point solvent and blow out any foreign particles that may be in the valve with compressed air.

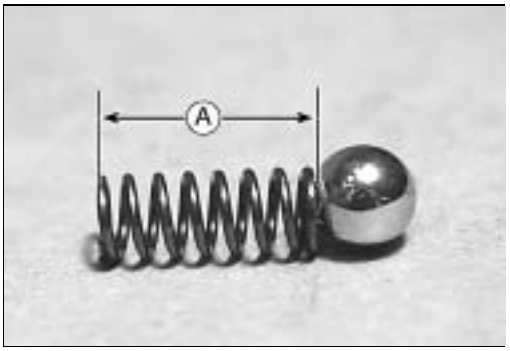
⚠ WARNING

Clean the parts in a well ventilated area, and take care that there is no spark or flame anywhere near the working areas. Because of the danger of highly flammable liquids, do not use gasoline or low flash-point solvents.

Oil Pump and Relief Valve

★If cleaning does not solve the problem, replace the relief valve parts.
★If necessary, put the ball in position and lightly tap the ball with a suitable tools to form a perfect seat.
● Measure free length [A] of the spring with a vernier caliper.
★If the free length of the spring is less than the service limit, replace the spring.

Free Length of Spring
Service Limit: 19.50 mm (0.77 in.)

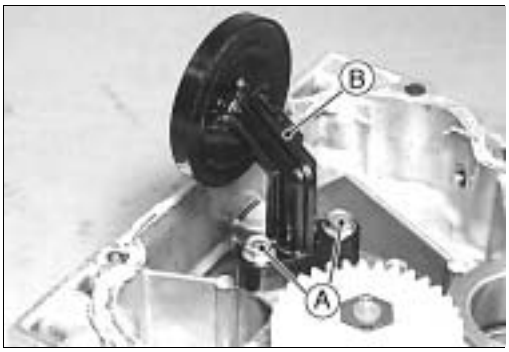


Oil Screen Filter

The oil screen filter cannot be disassembled, if any damage for the oil screen filter is noticed replace it with a new one.

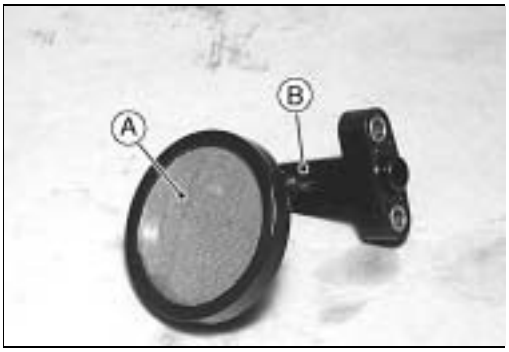
Removal

- Remove the crankcase cover (see Camshaft/Crankcase chapter).
- Unscrew the mounting bolts [A] and remove the oil screen filter [B].



Cleaning and Inspection

- Clean the oil screen [A] with high flash-point solvent and remove any particles stuck to it.



⚠WARNING

Clean the screen in a well-ventilated area, and take care that there is no spark or flame anywhere near the working area. Because of the danger of highly flammable liquids, do not use gasoline or low flash-point solvents.

NOTE

○ *While cleaning the screen, check for any metal particles that might indicate internal engine damage.*

- Check the screen carefully for any damage: holes and broken wire.

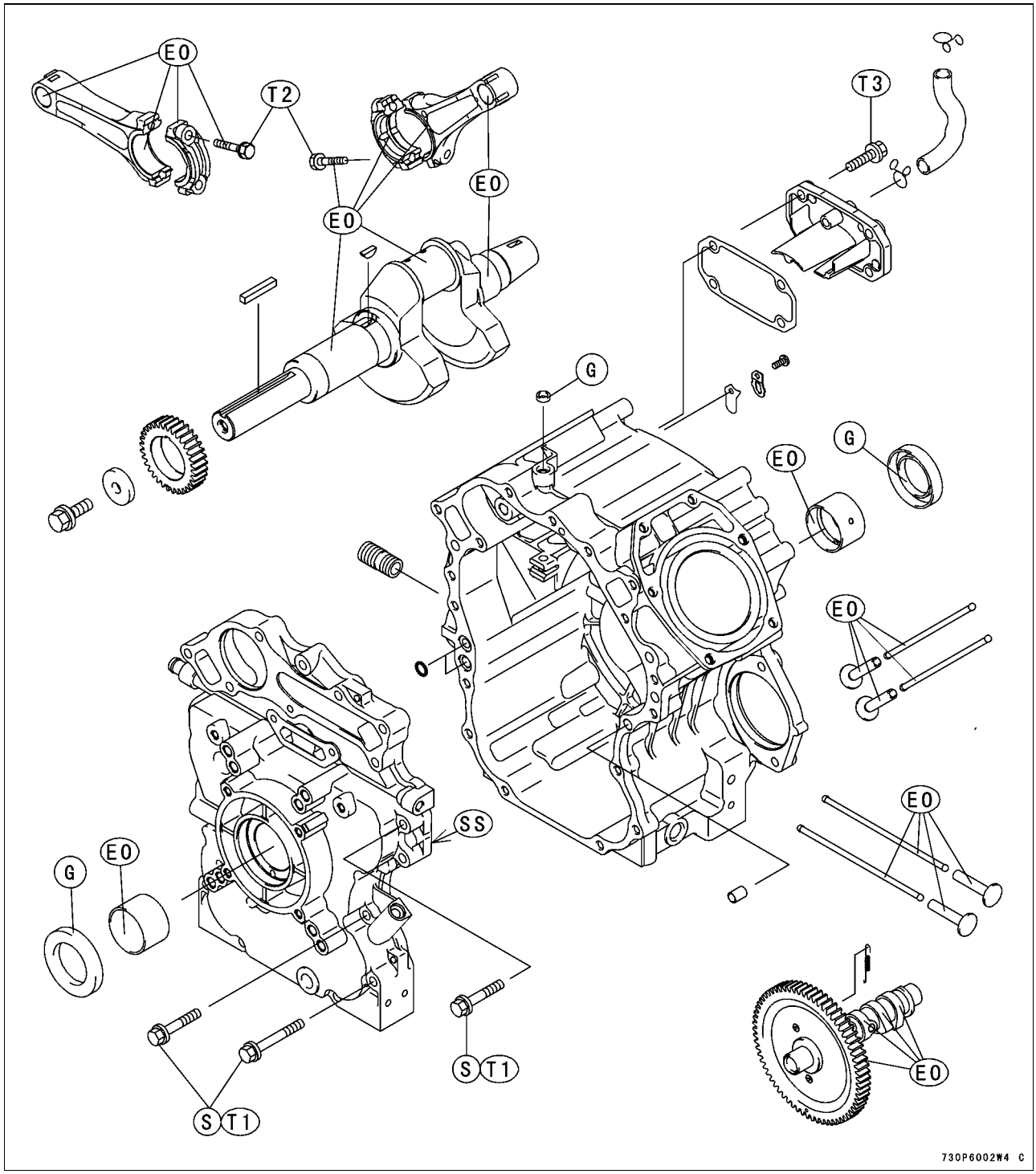
★If the screen is damaged, replace the oil screen filter [B].

Camshaft/Crankshaft

Table of Contents

Exploded View....6-2
Specifications....6-3
Crankcase....6-4
Crankcase Cover Removal....6-4
Crankcase Cover Installation....6-4
Inspection....6-5
Journal Bushing Replacement....6-6
For Designing Bushing Tools....6-7
Breather....6-8
Removal....6-8
Installation Notes....6-8
Inspection....6-8
Camshaft, Tappet....6-9
Camshaft, Tappet Removal....6-9
Camshaft, Tappet Installation....6-9
Camshaft Inspection....6-9
Camshaft Bearing/Journal Wear....6-9
Crankshaft, Connecting Rod....6-11
Connecting Rod Removal....6-11
Connecting Rod Installation....6-11
Crankshaft Removal....6-11
Crankshaft Installation....6-11
Cleaning/Inspection....6-11
Connecting Rod Bend/Twist....6-11
Connecting Rod Big End/Crankpin Width Wear....6-12
Connecting Rod Big End Bearing/Crankpin Wear....6-12
Crankshaft Runout....6-13
Crankshaft Main Journal/Wear....6-13

Exploded View



EO: Apply engine oil.
G: Apply grease.
S: Follow the specific tightening sequence.
SS: Apply silicone sealant.

T1: 22 N·m (2.2 kg·m, 16 ft·lb)
T2: 21 N·m (2.1 kg·m, 15 ft·lb)
T3: 20 N·m (2.0 kg·m, 15 ft·lb)

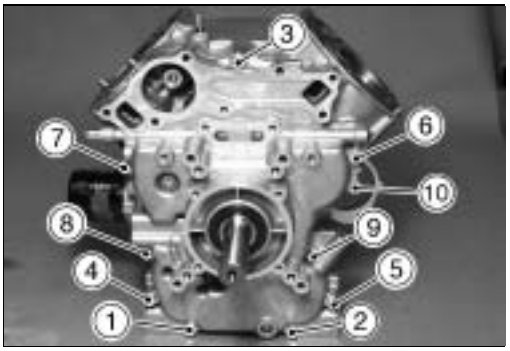
Specifications

Item		Service Limit
Camshaft, Tappet:		
Cam lobe height	Intake	33.594 mm (1.3226 in.)
	Exhaust	33.594 mm (1.3226 in.)
Camshaft journal diameter	PTO side	19.927 mm (0.7845 in.)
	Flywheel side	19.927 mm (0.7845 in.)
Camshaft bearing inside diameter	Crankcase	20.081 mm (0.7906 in.)
	Crankcase cover	20.081 mm (0.7906 in.)
Crankshaft, Connecting Rod:		
Connecting rod bend		0.15/100 mm (0.006/3.94 in.)
Connecting rod twist		0.15/100 mm (0.006/3.94 in.)
Connecting rod big end width		22.35 mm (0.88 in.)
Crankpin width		46.5 mm (1.83 in.)
Connecting rod big end inside diameter		40.055 mm (1.5770 in.)
Crankpin outside diameter		39.950 mm (1.5728 in.)
Crankshaft runout		0.05 mm (0.002 in.) TIR
Crankshaft journal diameter	PTO side	41.935 mm (1.6510 in.)
	Flywheel side	41.935 mm (1.6510 in.)
Crankcase:		
PTO shaft bearing inside diameter	Crankcase cover	42.092 mm (1.6572 in.)
Crankshaft journal bearing inside dia.	Crankcase	42.140 mm (1.6591 in.)

6-4 CAMSHAFT/CRANKSHAFT

Crankcase

Crankcase Cover Removal



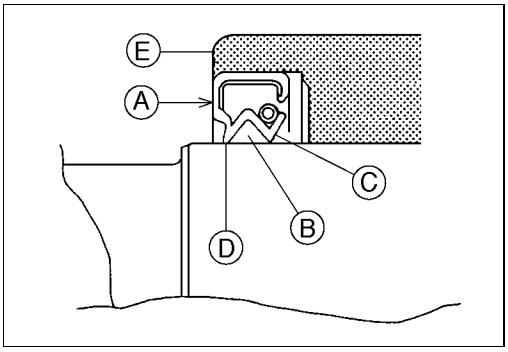
- Set the engine on a clean surface while parts are being removed.
- Drain the oil (see Lubrication System chapter).
- Remove (see appropriate chapter).
  - Muffler Assembly
  - Air Cleaner Assembly
  - Carburetor Assembly
  - Throttle Control Panel
  - Radiator
  - Radiator Hoses and Bypass Tube
  - Water Pump Assembly
  - Cooling Fan and Brackets
  - Cylinder Head Assemblies
  - Intake Manifold
  - Flywheel
  - Stator Coil
  - Ignition Coils
  - Starter Motor
- Unscrew the mounting bolts in the order shown and pull the crankcase cover from the crankcase.
- ○ There are two knock pins on the crankcase mating surface. A wooden or plastic mallet may be used to gently tap loose the crankcase cover.

Crankcase Cover Installation

- Chip off the old gasket from the mating surfaces of the crankcase and cover.
- Using compressed air, blow out the oil passage in the crankcase cover.
- With a high flash-point solvent, clean off the mating surfaces of the crankcase and cover, and wipe dry.

⚠ WARNING

Clean the crankcase and cover in a well-ventilated area, and take care that there are no sparks or flame anywhere near the working area; this includes any appliance with a pilot light. Do not use gasoline or a low flash-point solvent to clean parts. A fire or explosion could result.

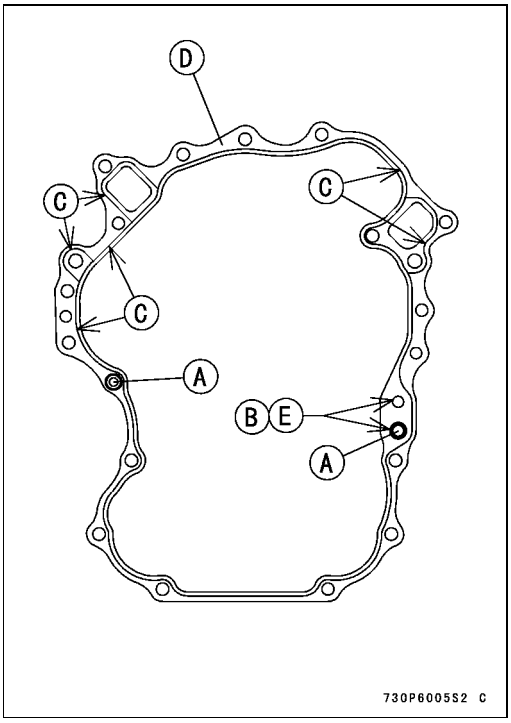


- Be sure to replace any oil seal removed with a new one.
- ○ Install the oil seal so that the marks [A] face out.
- ○ Pack some amount of a high temperature grease [B] into the space between the seal lip [C] and dust lip [D]. Press in the new oil seal using a press or suitable tools until it is flush with flange surface [E]. Do not damage the seal lips.

Crankcase

(Crankcase installation)
- Check to see that the crankcase dowel pins [A] are in place on the crankcase as shown in the figure.
- Check to see that the O-rings [B] are in place on the crankcase as shown in the figure.
- Apply sealant bead [C] (wide 1∼2 mm) to the mating surface [D] of the crankcase as shown in the figure.

Sealant - Kawasaki Bond (Silicone Sealant): 56019–120



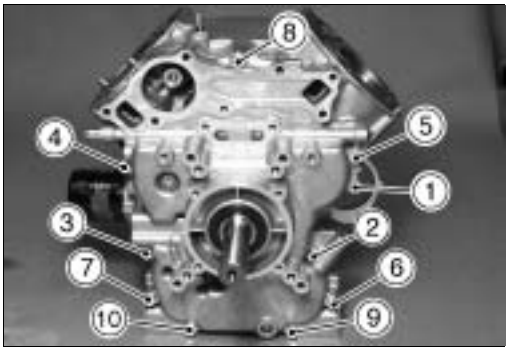
CAUTION

Does not get the sealant into the oil line hole [E] on the crankcase or crankcase cover.

- Install the gasket on the crankcase.
- Install the crankcase cover and tighten the crankcase cover bolts following the tightening sequence shown.

Torque - Crankcase Cover Bolts: 22 N·m (2.2 kg·m, 16 ft·lb)

○ Note the position of different length of the bolts.
○ Do not turn one screw down completely before the others, as it may cause the crankcase cover to warp.



Inspection
- Clean up the crankcase and cover with a high flash-point solvent, and blow out any foreign particles that may be in the pockets inside of the crankcase with compressed air.

⚠WARNING

Clean the crankcase and cover in a well-ventilated area, and take care that there is no spark or flame anywhere near the working area. Because of the danger of highly flammable liquids, do not use gasoline or low flush-point solvents.

- Inspect the crankcase for accumulation of rust, scale and lime in the water jacket.

★If this accumulation is observed, flush the cooling system (see Flushing in Cooling System chapter).

- Inspect the crankcase for coolant leakage out side water jacket. Small leaks may appear only as rust, corrosion or stains, due to evaporation.

Gasket:	Tighten a parts or install a new gasket. Use a sealing compound when required.
Bolts:	Apply sealing compound when required.

- Inspect the crankcase for coolant leakage into the engine.
  [A] Water Jacket
  [B] Gasket Surfaces
  [C] Push Rod Compartment

Crankcase

- A coolant leaks into the engine through:
  A loose cylinder head
  A cracked or porous casting
  The push rod compartment
- Give special attention to the cylinder head gasket.

★If coolant leaks from the gasket surfaces:

○ Check the gasket surfaces for burn and traces of the gas leakage, replace the gasket if necessary.

○ Check the cylinder head and block surfaces are clean, level and smooth. (see Engine Top End chapter)

○ Check the cylinder head for correct installation (see Engine Top End chapter).

- A cracked or porous casting are not visible to eye, an evidence of leakage of the coolant from suspected area are found, replace the crankcase (block).

★If a coolant leakage from the push rod compartment is appeared replace the crankcase (block).

- Measure the inside diameter [A] of the PTO shaft bearing on the crankcase cover at several points. This bearing is not replaceable. Replace the crankcase cover if the inside diameter is more than the service limit.

PTO Shaft Bearing Inside Diameter
Service Limit: 42.092 mm (1.6572 in.)

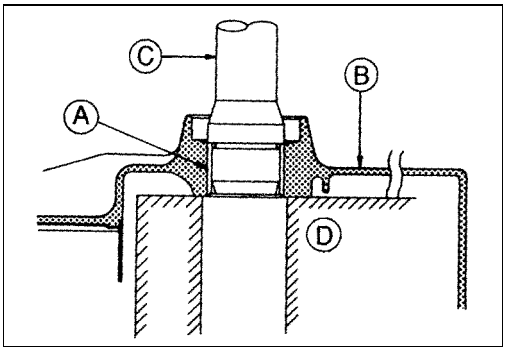
- Measure the inside diameter [A] of the crankshaft journal bearing on the crankcase at several points. Replace the journal bushing if the inside diameter is more than the service limit.

Crankshaft Journal Bearing Inside Diameter
Service Limit: 42.140 mm (1.6591 in.)

Journal Bushing Replacement

The journal bushing [A] is press fit into the crankcase [B].

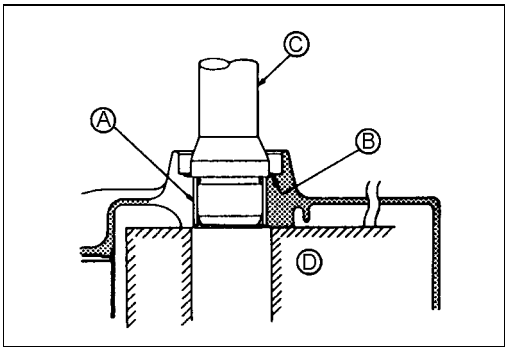
- Remove the oil seal on the crankcase.
  The oil seal should not be reused once removed.
- Place the crankcase on a support block [D] with the oil seal side up.
- Using a bushing tool [C], drive out the bushing as shown.



Crankcase

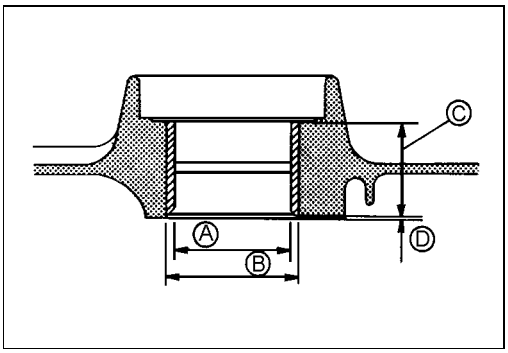
- The service bushing is to be reinstalled using a bushing tool as shown.
- Coat the bushing and flange surface with light film of oil, press in the new bushing flush with the flange surface.
- No finish reaming is required.

[A] New Bushing
[B] Flange Surface
[C] Bushing Tool
[D] Support Block



For Designing Bushing Tools

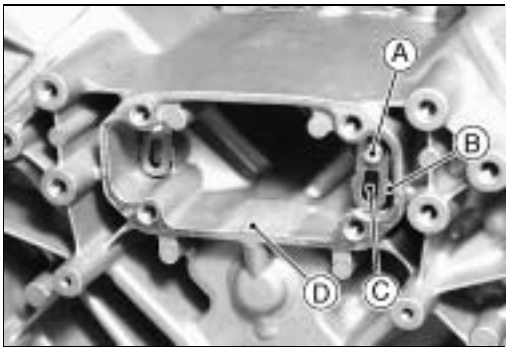
[A] Bushing Inside Diameter (MIN)
41.997 mm (1.6534 in.)
[B] Housing Inside Diameter (MIN)
46.000 mm (1.8110 in.)
[C] Bushing Width
28.5 mm (1.12 in.)
[D] Bushing Counter Sunk
0.5 mm (0.02 in.)

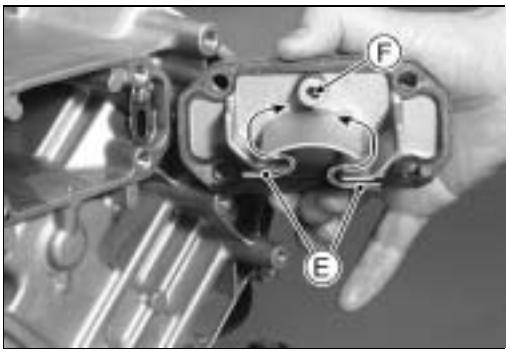


Breather

The function of the breather is to create a vacuum in the crankcase which prevents oil from being forced out of the engine through the piston rings, oil seals or gaskets. The breather has a reed valve [C], which limits the direction of air flow caused by the piston moving up and down. Air can flow out of the crankcase, but the one way reed valve blocks return flow. It thus maintains a vacuum in the crankcase.

Oil laden air in the crankcase passes through the reed valve and expand into the breather chamber. Here most oil separates from the air and drains back to the crankcase. The air passes through a maze [E] and vents to the air cleaner [F].





Removal

- Remove the breather chamber cover.
- Unscrew the mounting screw [A], and remove the back plate [B] and reed valve.

Installation Notes

- Be sure the drain hole [D] does not accumulate with slugges before installing the breather valve.
- Align center of the valve seat with center of the reed valve and back plate, then tighten the mounting screw.

NOTE

○ *The mounting screw is a self-tapping one. Be aware that mis-threading or overtightening screw will strip the female threads and ruin the hole.*

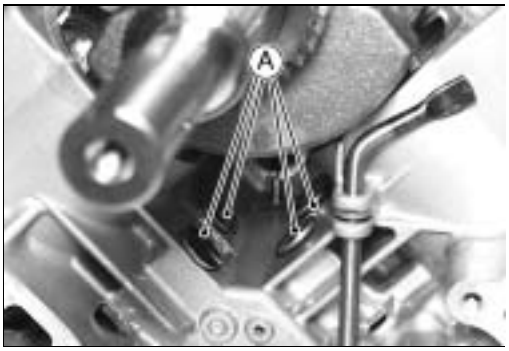
Inspection

- Inspect the reed valve for breakage, hair cracks or distortion, replace it if necessary.
- Inspect the back plate for damage or rough contact surface, replace it if necessary.
- Inspect the valve seating surface. The surface should be free of nicks or burrs.

Camshaft, Tappet

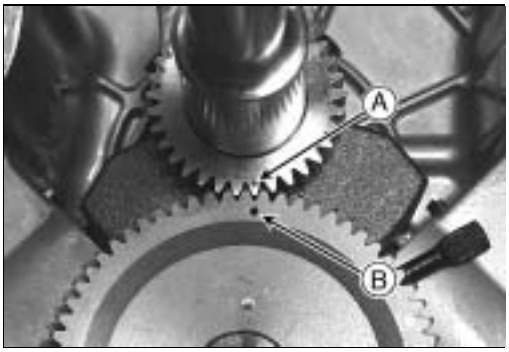
Camshaft, Tappet Removal

- Remove the crankcase cover (see Crankcase Cover Removal).
- Turn the crankcase up side down so that the tappets will fall away from the cam lobes.
- Pull the camshaft out of the crankcase.
- Remove the tappets [A] and mark them so they can be installed in their original positions during assembly.



Camshaft, Tappet Installation

- Apply engine oil to the following.
  Tappet Journal
  Camshaft Journal
  Cam Lobe Surface
  Camshaft Gear
- Align the punch marks [A] on the crankshaft gear with punch mark [B] on the camgear.



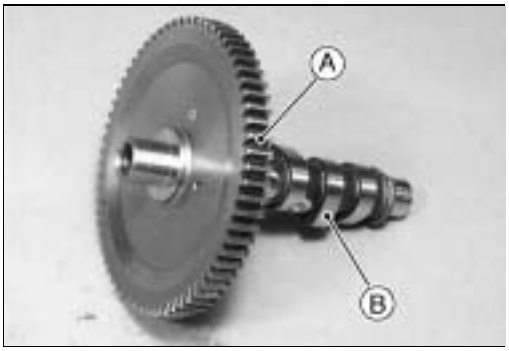
Camshaft Inspection

- Check the camshaft gear [A] for pitting, fatigue cracks, burrs or an evidence of improper tooth contact.

★Replace the shaft if necessary.

- Check the top of the cam lobes [B] for wear, burrs or uneven contact.

★Replace the shaft if necessary.



Camshaft Bearing/Journal Wear

- Measure the height of each cam lobe.

★If the cam height is less than the service limit for either lobe, replace the camshaft.

Cam Lobe Height

Service Limit:	**IN. 33.594 mm (1.3226 in.)**
	EX. 33.594 mm (1.3226 in.)

- Measure both camshaft journals at several points around the journal circumference.

★If the journal diameter is less than the service limit, replace the camshaft.

PTO Side Camshaft Journal Diameter

Service Limit:	**19.927 mm (0.7845 in.)**

Flywheel Side Camshaft Journal Diameter

Service Limit:	**19.927 mm (0.7845 in.)**

Camshaft, Tappet

● Measure the inside diameter [A] of the camshaft bearing on the crankcase at several points. This bearing is not replaceable.
★ Replace the crankcase if the inside diameter is more than the service limit.

Camshaft Bearing Inside Diameter (Crankcase)
Service Limit: 20.081 mm (0.7906 in.)

● Measure the inside diameter [A] of the camshaft bearing on the crankcase cover at several points. This bearing is not replaceable.
★ Replace the crankcase cover if the inside diameter is more than the service limit.

Camshaft Bearing Inside Diameter (Crankcase Cover)
Service Limit: 20.081 mm (0.7906 in.)

Crankshaft, Connecting Rod

Connecting Rod Removal

● Remove:
Piston (see Engine Top End Chapter)

Connecting Rod Installation

● Install:
Piston (see Engine Top End chapter)

Crankshaft Removal

● Set the engine on a clean surface while parts are being removed.
● Drain the oil (see Lubrication System chapter).
● Remove:
Flywheel (see Electrical System chapter)
Camshaft (see Camshaft, Tappet Removal)
Connecting Rod and Piston Assembly (see Engine Top End chapter)
● Pull the crankshaft [A] out of the crankcase. Tap gently with a wooden or plastic mallet if necessary to loosen the crankshaft.

Crankshaft Installation

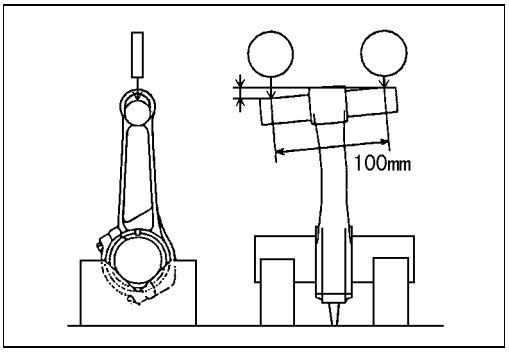
● Clean up the crankshaft and crankcase thoroughly, especially at the bearing contact surfaces.
● Pack some amount of high temperature grease into the oil seal on the crankcase.
● Apply engine oil to the journal and bearing.
● Carefully insert the crankshaft flywheel end into the main bearing and oil seal in the crankcase.

Cleaning/Inspection

● After removing, clean the crankshaft and connecting rods with a high flash-point solvent and dry them with compressed air.
● Inspect the teeth of the crankshaft gear for pitting, fatigue cracks, burrs and evidence of improper tooth contact.
★Replace the gear if necessary.
● Inspect the crankshaft and connecting rods especially at the bearing surfaces for wear, scratches, evidence of improper contact or other damages.
★Replace them if necessary.

Connecting Rod Bend/Twist

● Measure connecting rod bend.
○ Select an arbor of the same diameter as the connecting rod big end, and insert the arbor through the connecting rod big end.
○ Select an arbor of the same diameter as the piston pin and at least 100 mm long, and insert the arbor through the connecting rod small end.
○ On a surface plate, set the big-end arbor on V blocks.
○ With the connecting rod held vertically, use a height gauge to measure the difference in the height of the small end arbor above the surface plate over a 100 mm length to determine the amount of connecting rod bend.
★If connecting rod bend exceeds the service limit, the connecting rod must be replaced.

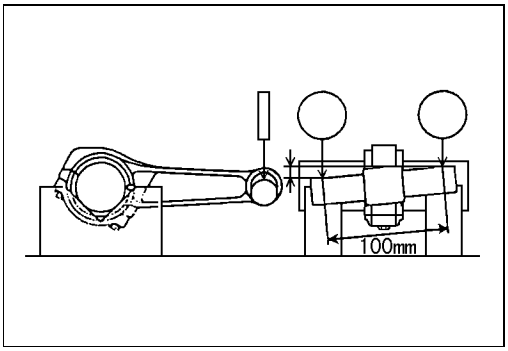


Connecting Rod Bend
Service Limit: **0.15/100 mm (0.006/3.94 in.)**

Crankshaft, Connecting Rod

● Measure connection rod twist.
○ With the big-end arbor still on the V blocks, hold the connection rod horizontally and measure the amount that the small end arbor varies from being parallel with the surface plate over a 100 mm length of the arbor to determine the amount of connecting rod twist.
★ If connecting rod twist exceeds the service limit, the connecting rod must be replaced.

Connecting Rod Twist
Service Limit: **0.15/100 mm (0.006/3.94 in.)**

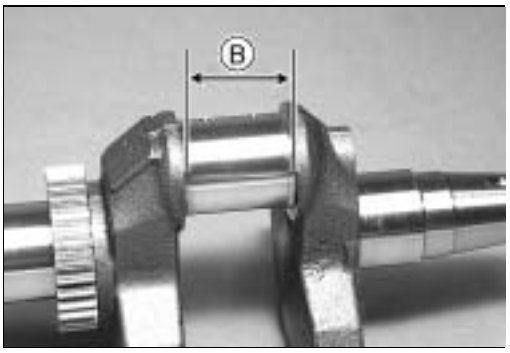


Connecting Rod Big End/Crankpin Width Wear
● Measure the connecting rod big end width [A] with a micrometer or dial caliper.
★ If the measurement is less than the service limit, replace the connecting rod.

Connecting Rod Big End Width
Service Limit: **22.35 mm (0.88 in.)**

● Measure the crankpin width [B] with a dial caliper.
★ If the crankpin width is more than the service limit, replace the crankshaft.

Crankpin Width
Service Limit: **46.5 mm (1.83 in.)**



Connecting Rod Big End Bearing/Crankpin Wear
● Apply a light film of oil on the thread of the cap bolts.
● Install the cap bolts and tighten the bolts to the specified torque (see Piston Installation in Engine Top End chapter).
● Measure the inside diameter [A] of big end at several points with a telescoping gauge or inside micrometer.
★ If the inside diameter is more than the service limit, replace the connecting rod with a new one.

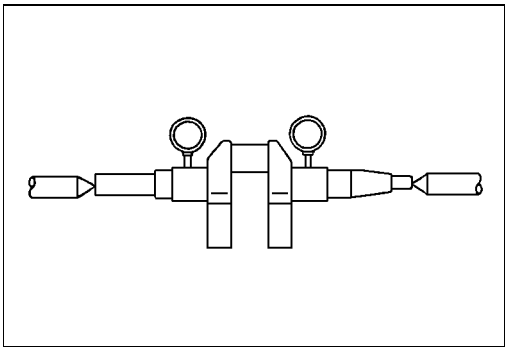
Connecting Rod Big End Inside Diameter
Service Limit: **40.055 mm (1.5770 in.)**

● Measure the crankpin outside diameter [A].
○ Use a micrometer to measure several points around the crankpin circumference.
★ If the crankpin diameter is less than the service limit, replace the crankshaft with a new one.

Crankpin Outside Diameter
Service Limit: **39.950 mm (1.5728 in.)**

Crankshaft, Connecting Rod

Crankshaft Runout



- ● Measure the crankshaft runout.
- ○ Set the crankshaft in a flywheel alignment jig or on V blocks gauge.
- ○ Set a dial gauge against both bearing journals.
- ○ Turn the crankshaft slowly to measure the runout. The difference between the highest and lowest dial gauge readings (TIR) is the amount of runout.
- ★ If the measurement exceeds the service limit, replace the crankshaft.

Crankshaft Runout
Service Limit: 0.05 mm (0.002 in.) TIR

Crankshaft Main Journal/Wear

- ● Measure both main journals at several points around the journal circumference.
- ★ If the journal diameter is less than the service limit, replace the crankshaft with a new one.

PTO Side Crankshaft Journal Diameter [A]
Service Limit: 41.935 mm (1.6510 in.)

Flywheel Side Crankshaft Journal Diameter [B]
Service Limit: 41.935 mm (1.6510 in.)

Electrical System

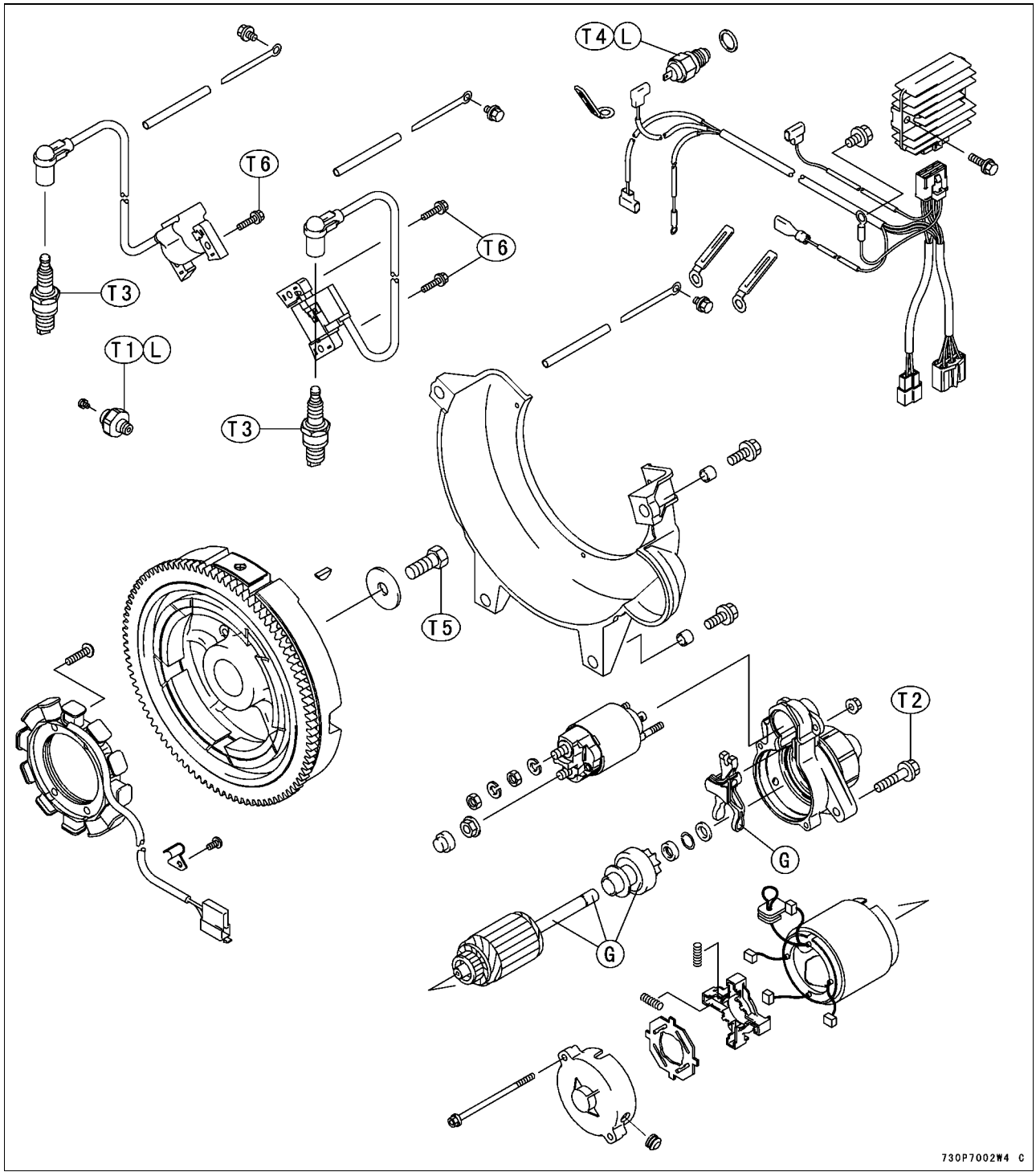
Table of Contents

Exploded View....7-2
Specifications....7-3
Wiring Diagram....7-4
Wire Harness....7-6
Precautions....7-7
Charging System....7-8
- Flywheel, Stator Coil Removal....7-8
- Stator Coil (Charging Coil):....7-8
- Flywheel, Stator Coil Installation....7-8
- Charging System Operational Inspection....7-9
- Stator Coil Resistance....7-9
- Unregulated Stator Output....7-10
- Regulator Resistance....7-10

Ignition System....7-11
- Ignition System....7-11
- Ignition Coil Removal....7-11
- Ignition Coil Installation....7-11
- Ignition Coil Inspection....7-12
- Spark Plug Cleaning and Inspection....7-12
- Spark Plug Gap Inspection....7-12

Electric Starter System....7-13
- Starter Motor Removal....7-13
- Starter Motor Installation....7-13
- Starter Solenoid and Circuit Test....7-13
- Starter Motor Test....7-14
- No-Load Starter Draw Bench Test....7-14
- Starter Motor Disassembly....7-15
- Starter Motor Assembly Notes....7-16
- Starter Motor Brush Inspection....7-18
- Brush Spring Inspection....7-18
- Armature Inspection....7-18
- Yoke Assembly Inspection....7-19
- Pinion Clutch Inspection....7-20

Exploded View

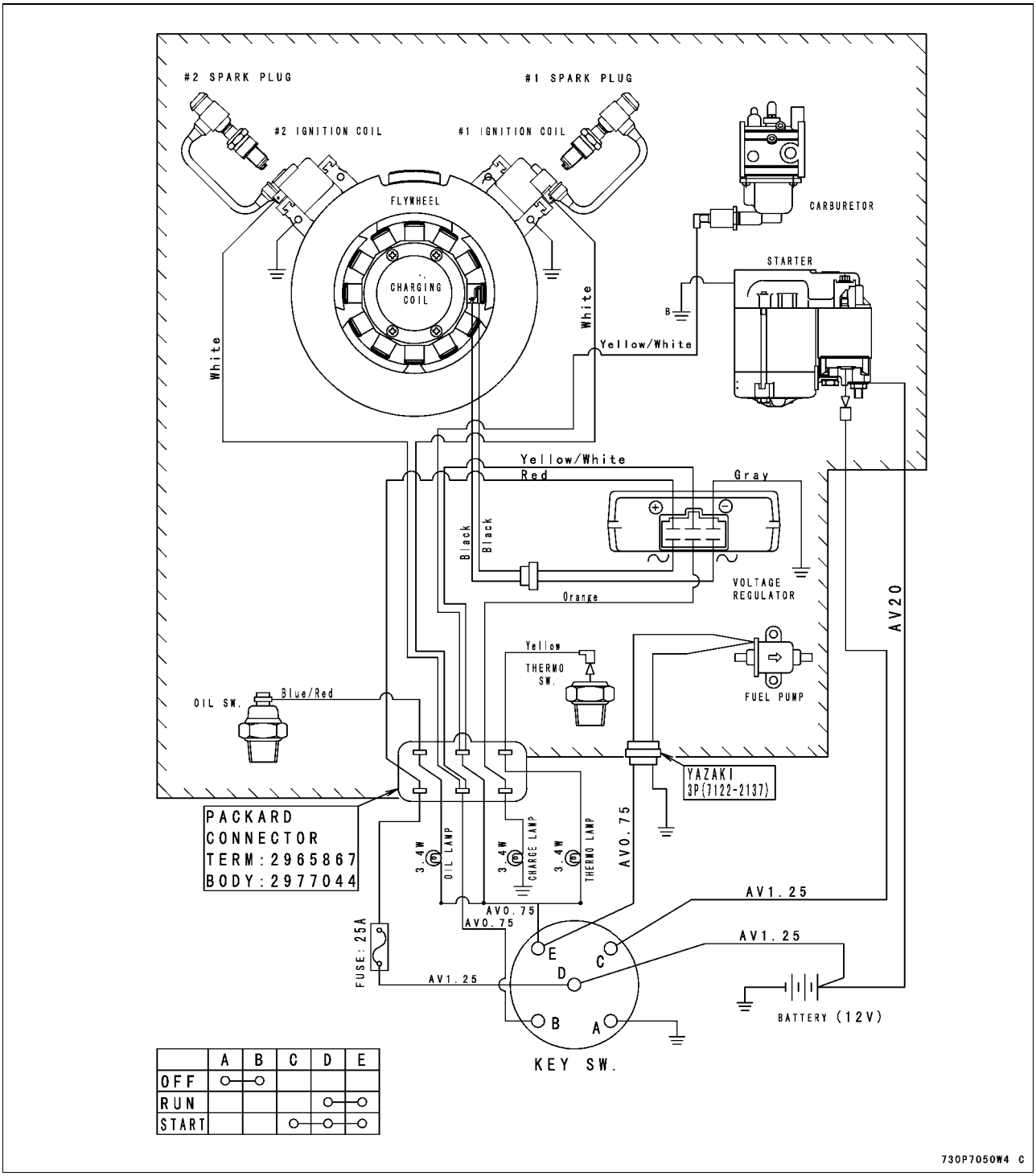


G: Apply grease.
L: Apply a non-permanent locking agent.
T1: 15 N·m (1.5 kg·m, 11 ft·lb)
T2: 20 N·m (2.0 kg·m, 15 ft·lb)
T3: 25 N·m (2.5 kg·m, 18 ft·lb)
T4: 27 N·m (2.8 kg·m, 20 ft·lb)
T5: 56 N·m (5.7 kg·m, 41 ft·lb)
T6: 3.4 N·m (0.35 kg·m, 30 in·lb)

Specifications

Item	Standard	Service Limit
Charging System:		
Regulated output voltage	Battery voltage to 15 V DC	– – –
Alternator stator coil resistance	0.11 to 0.18 Ω	– – –
Unregulated stator output	– – –	26 VAC/3000 rpm
Regulator resistance	See charging system	
Ignition System:		
Ignition coil:		
Primary winding resistance	2.2 to 3.6 kΩ	– – –
Secondary winding resistance	13 to 21 kΩ	– – –
Spark Plug	NGK BPR2ES	– – –
Plug gap	0.75 mm (0.030 in.)	– – –
Electric Starter System:		
Starter motor:		
Carbon brush length	10 mm (0.394 in.)	6.0 mm (0.24 in.)
Commutator groove depth	0.5 to 0.8 mm (0.02 to 0.031 in.)	0.2 mm (0.008 in.)
Commutator diameter	28 mm (1.102 in.)	27 mm (1.06 in.)
Commutator runout	– – –	0.4 mm (0.016 in.)

Wiring Diagram



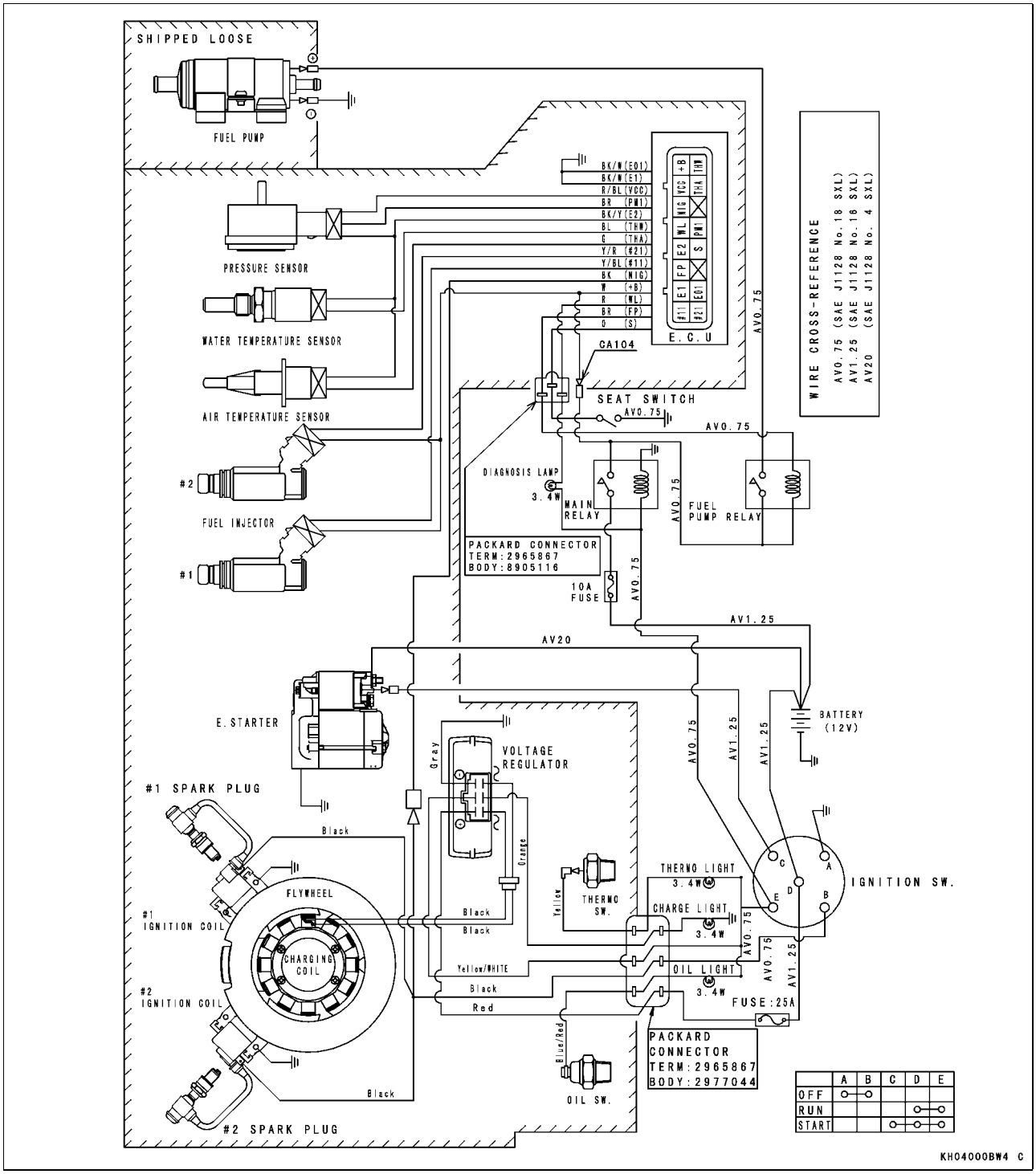
	A	B	C	D	E
OFF	○	○			
RUN				○	○
START			○	○	○

NOTE

○ *Portion surrounded by ////shows KHI procurement parts.*

Wiring Diagram

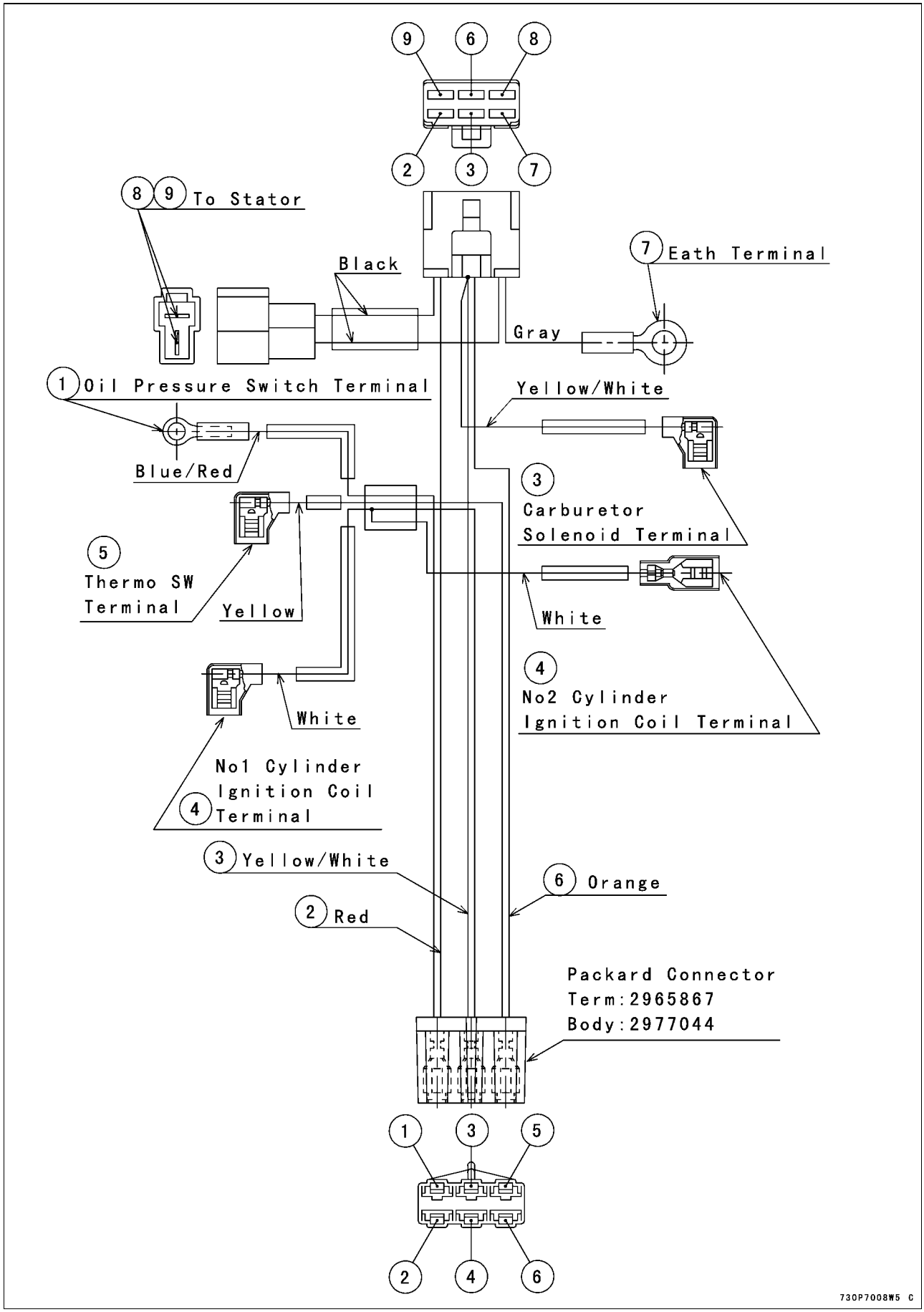
FD791D (DFI Model)



NOTE

○ *Portion surrounded by ////shows KHI procurement parts.*

Wire Harness

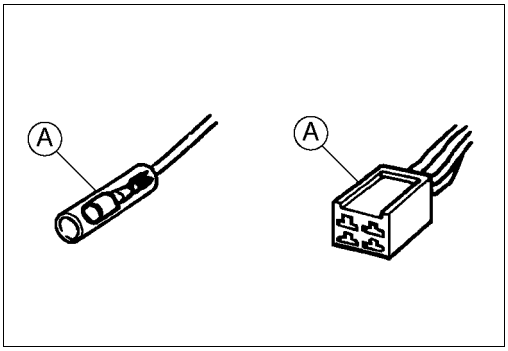


Precautions

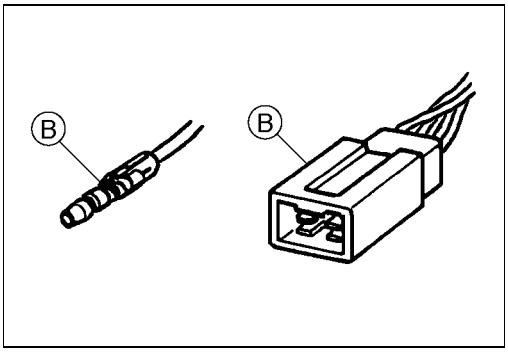
There are a number of important precautions that are musts when servicing electrical systems. Learn and observe all the rules below.

- Do not reverse the battery lead connections. This will burn out the diodes in the electrical parts.
- Always check battery condition before condemning other parts of an electrical system. A fully charged battery is a must for conducting accurate electrical system tests.
- The electrical parts should never be struck sharply, as with a hammer, or allowed to fall on a hard surface. Such a shock to the parts can damage them.
- To prevent damage to electrical parts, do not disconnect the battery leads or any other electrical connections when the engine switch is on, or while the engine is running.
- Because of the large amount of current, never keep the engine switch turned to the start position when the starter motor will not turn over, or the current may burn out the starter motor windings.
- Take care not to short the leads that the directly connected to the battery positive (+) terminal to the chassis ground.
- Troubles may involve one or in some cases all items. Never replace a defective part without determining what CAUSED the failure. If the failure was brought on by some other item or items, they too must be repaired or replaced, or the replacement part will soon fail again.
- Make sure all connectors in the circuit are clean and tight, and examine wires for signs of burning, fraying, etc. Poor wires and bad connections will affect electrical system operation.
- Measure coil and winding resistance when the part is cold (at room temperature).
- Electrical Connectors:

Female Connectors [A]



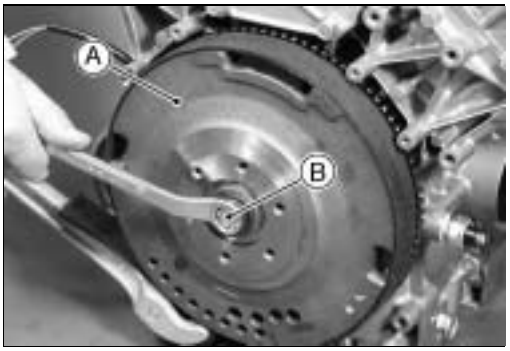
Male Connectors [B]



Charging System

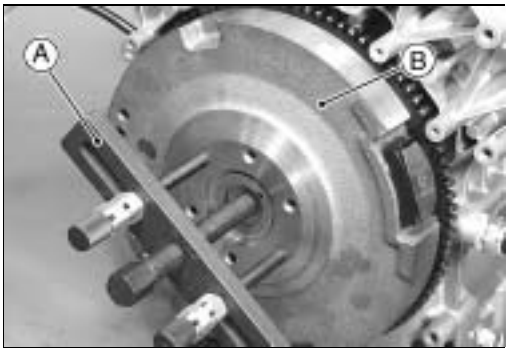
Flywheel, Stator Coil Removal

- Remove:
  Radiator
  Cooling Fan
  Starter Motor
  Fan Drive Sheave/Hub
- Hold the flywheel [A] with a suitable tools, remove the flywheel mounting bolt [B].



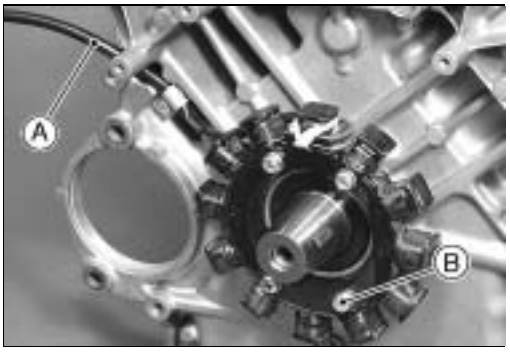
- Using a suitable flywheel puller [A], remove the flywheel [B].

CAUTION
Always use flywheel puller.



Stator Coil (Charging Coil):

- Note the stator coil output leads [A] position for reinstalling the stator coil.
- Unscrew the coil mounting screws [B] and remove the stator coil.

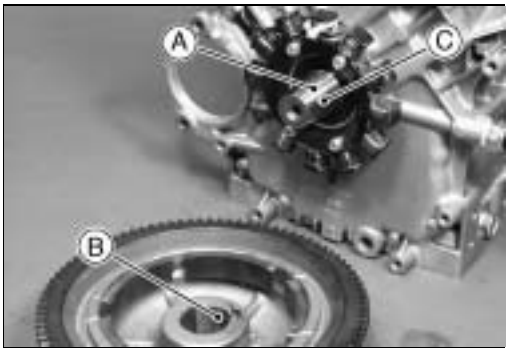


Flywheel, Stator Coil Installation

- Install the stator coil and tighten the screws.

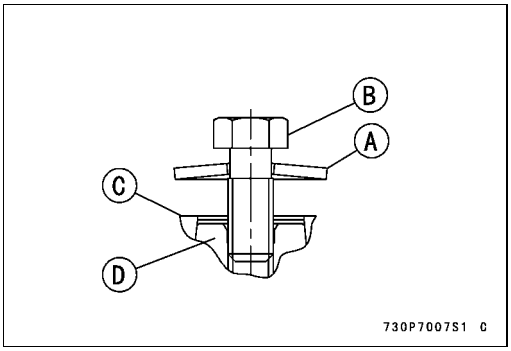
  Torque - Stator Coil Screws: 3.4 N·m (0.35 kg·m, 30 in·lb)

- Using a cleaning fluid, clean off any oil or dirt on the following portions and dry them with a clean cloth.
  [A] Crankshaft Tapered Portion
  [B] Flywheel Tapered Portion
- Fit the woodruff key [C] securely in the slot in the crankshaft before installing the flywheel.



- Install the flywheel onto the crankshaft taper so that the woodruff key fits in the key way in the hub of the flywheel.
- Put the (coned disc spring) washer [A] in the direction as shown and tighten the flywheel bolt [B].
  [C] Flywheel
  [D] Crankshaft

  Torque - Flywheel Bolt: 56 N·m (5.7 kg·m, 41 ft·lb)



Charging System

Charging System Operational Inspection

● Check battery condition.

NOTE

○ *Always check battery condition before condemning other parts of the charging system. The battery must be fully charged in order to conduct accurate charging system tests.*

● Warm up the engine to bring the components up to their normal operating temperatures.
● Measure regulated output voltage at various engine speeds.
○ Connect a voltmeter across the battery terminals.
★ The readings should show nearly battery voltage when the engine speed is low, and as the engine speed rises, the readings should also rise. But they must stay within the specified range.
★ If the output voltage is much higher than the specification, the regulator is defective, or the regulator leads are loose or open.
★ If the output voltage dose not rise as the engine speed increase, the regulator is defective or the alternator output is insufficient for the loads.

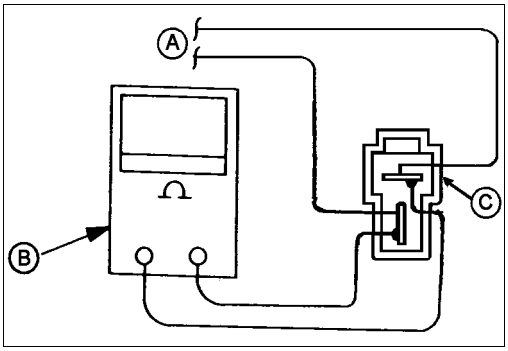
Regulated Output Voltage
Battery Voltage to 15 VDC

Stator Coil Resistance

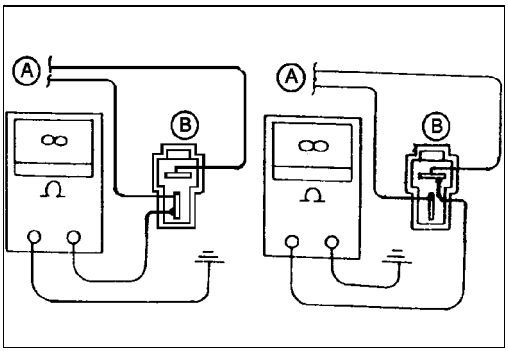
● Disconnect the stator coil connector.
● Measure the stator coil resistance.
○ Connect an ohmmeter between stator pins [C].

Stator Coil Resistance
0.11 to 0.18 Ω

★ If the meter does not read as specified, replace the alternator stator.
★ If the coil has normal resistance, but the voltage inspect showed the alternator to be defective; the rotor magnets have probably weakened, and the rotor must be replaced.
[A] To Stator
[B] Ohm Meter
[C] Stator Coil Connector



● Check for continuity between each stator pin and ground. There should be no continuity (infinite ohm).
★ If the stator coil fails any of these tests, replace the coil with a new one.
[A] To Stator
[B] Stator Coil Connector



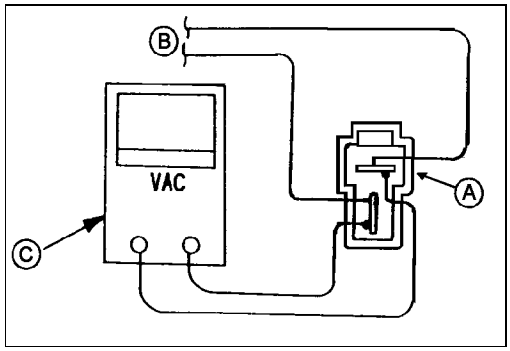
Charging System

Unregulated Stator Output

- Disconnect the stator coil connector.
- Connect AC voltmeter to the stator pins.
- Start the engine. Run the engine at the 3 000 rpm speed.
- Voltage reading should be minimum 26 VAC/3 000 rpm.

★If the AC voltage reading is less than the specification replace the stator.

Unregulated Stator Output (MIN)
26 VAC/3 000 rpm



[A] Stator Coil Connector
[B] To Stator
[C] AC Voltmeter

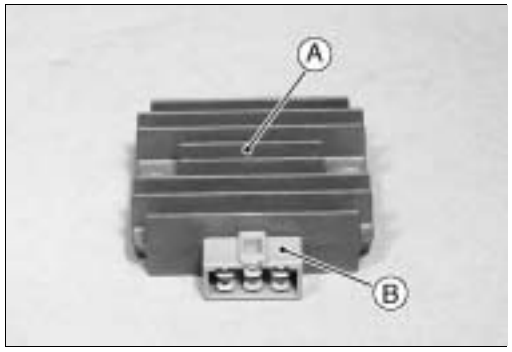
Regulator Resistance

- Set the KAWASAKI Hand Tester selector switch to the R × 100 Ω position.

Special Tool - Hand Tester: 57001–1394

- Connect the test leads to the points shown on the chart and read the resistance.

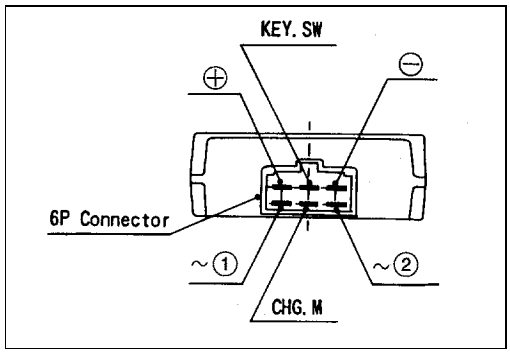
★If the resistance is not as specified replace the regulator.



NOTE

○ *This voltage regulator is an open type one.*

[A] Regulator
[B] 6P Conenctor



By KAWASAKI TESTER **Range: R x 100 Ω**

(–) TESTER (+)	~ 1	~ 2	+	—	Key.SW	CHG.M
~ 1	—	10 kΩ ~ 1 MΩ	∞	50 Ω ~ 5 kΩ	1 kΩ ~ 200 kΩ	1 kΩ ~ 200 kΩ
~ 2	10 kΩ ~ 1 MΩ	—	∞	50 Ω ~ 5 kΩ	1 kΩ ~ 200 kΩ	1 kΩ ~ 200 kΩ
+	∞	∞	—	∞	∞	∞
—	10 kΩ ~ 1 MΩ	10 kΩ ~ 1 MΩ	∞	—	500 Ω ~ 50 kΩ	500 Ω ~ 50 kΩ
Key.SW	∞	∞	∞	∞	—	∞
CHG.M	10 kΩ ~ 1 MΩ	10 kΩ ~ 1 MΩ	∞	50 Ω ~ 5 kΩ	1 kΩ ~ 200 kΩ	—

NOTE

○ *Resistance value may vary with individual meter.*

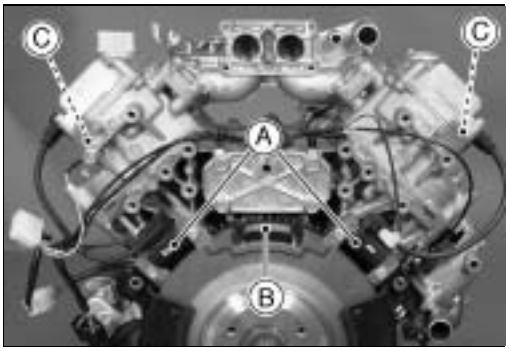
Ignition System

Ignition System

This engine ignition is controlled by a solid state ignition assembly and requires no periodic maintenance except for the spark plugs.

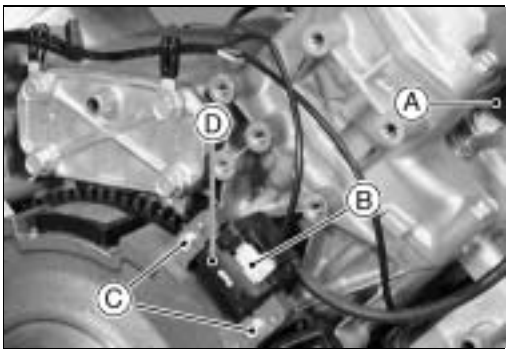
The system consists of the following:

Inductive Ignition Assemblies [A]
Permanent Magnet Flywheel [B]
Spark Plugs [C]
Stop Switch



Ignition Coil Removal

● Remove:
Radiator (see Cooling System chapter)
Cooling Fan (see Cooling System chapter)
Fan Drive Sheave/Hub (see Cooling System chapter)
Spark Plug Cap [A]
Stop Switch Lead Connector [B]
Bolts [C]
Ignition Coil [D]



Ignition Coil Installation

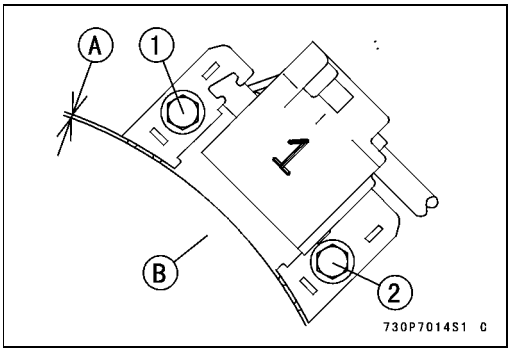
● Install ignition coil on crankcase, and tighten bolt (1) first, then tightening bolt (2). While tightening bolts, adjust the air gap [A] between the legs of ignition coil and the flywheel [B] to the specified gap value as shown.

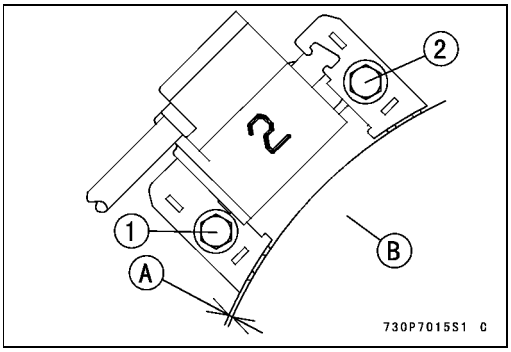
Ignition Coil Air Gap
Standard: 0.25 ~ 0.40 mm (0.010 ~ 0.016 in.)

Torque - Ignition Coil Mounting Bolts: 3.4 N·m (0.35 kg·m, 30 in·lb)

NOTE

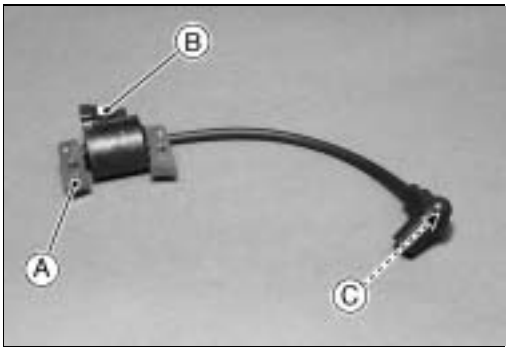
○ *Above procedure must be used to insure proper coil air gap is not too large.*





Ignition System

Ignition Coil Inspection



- Remove the ignition coils (see Ignition Coil Removal).
- Measure the primary winding resistance as follows:
  - Set the hand tester to the R × 1 kΩ range.

Special Tool - Hand Tester: 57001–1394

  - Make the measurements shown in the table.

Ignition Coil Primary Winding Resistance

—	+	A	B
A		—	∞
B		2.2~3.6 kΩ	—

CAUTION

Use only Tester 57001–1394 with new battery at room temperature for this test. A tester other than the Kawasaki Hand Tester should show different readings.
If a megger or a meter with a large-capacity battery is used, the ignition coil will be damaged.

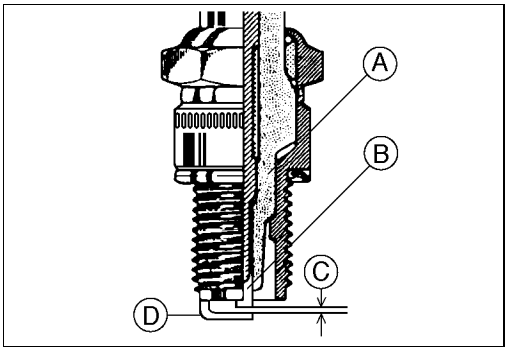
- Measure the secondary winding resistance as follows:
  - Set the hand tester to the R × 1 kΩ range.
  - Connect the tester between the iron core [A] and plug cap terminal [C].

Ignition Coil Secondary Winding Resistance

—	+	A	C
A		—	13~21 kΩ
C		13~21 kΩ	—

★If the tester dose not read as specified, replace the coil.

Spark Plug Cleaning and Inspection



- Carefully pull the plug cap from the spark plug, and remove the spark plug.

★If the plug is oily or has carbon built up on it, clean the plug using a high flash-point solvent and a wire brush or other suitable tool.

★If the spark plug electrodes are corroded or damaged, or if the insulator is cracked replace the plug. Use the standard spark plug or its equivalent.

[A] Insulator
[B] Center Electrode
[C] Plug Gap
[D] Side Electrode

Spark Plug Gap Inspection

- Measure the gap with a wire-type thickness gauge.

★If the gap is incorrect, carefully bend the side electrode with a suitable tool to obtain the correct gap.

Spark Plug Gap
Standard: 0.75 mm (0.030 in.)

Electric Starter System

Starter Motor Removal

- Disconnect the wires shown [A].
- Remove the mounting bolts [C] and pull the starter motor from the engine with the switch lead [B] attached.

Starter Motor Installation

- Clean the starter motor and engine mounting flanges to ensure good electrical contact and tighten the mounting bolts.

Torque - Starter Motor Mounting Bolts: 20 N·m (2.0 kg·m, 15 ft·lb)

Starter Solenoid and Circuit Test

NOTE

○ *Before this test, be sure the battery is fully charged.*

- Disconnect the starter motor lead [A] from the solenoid terminal as shown and keep the lead away from the solenoid terminal.

- Measure the continuity of the solenoid when activated.

○ Set the hand tester selector switch to the R x 1 Ω position and connect the leads across the large terminals [A] as shown.

○ Turn the engine switch to the START (II) position and read the tester.

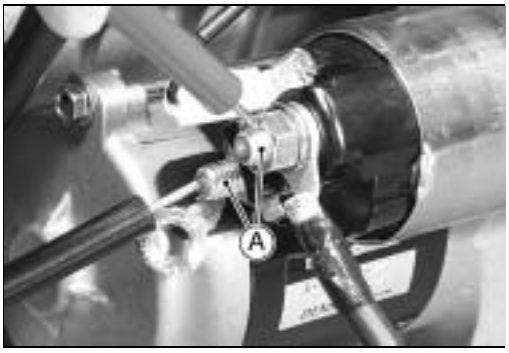
★ If the solenoid does not click or if the tester reads more than 0 Ω the solenoid is faulty. Replace it.

★ If the solenoid makes a single clicking sound, the tester reads 0 Ω and the pinion gear moves outward the solenoid and the rest of the starter circuit is good.

★ If solenoid clicks once but the tester does not read 0 Ω, the solenoid is faulty. Replace it.

★ If the solenoid does not click at all, proceed with the following.

- Disconnect the switch lead [A] shown.



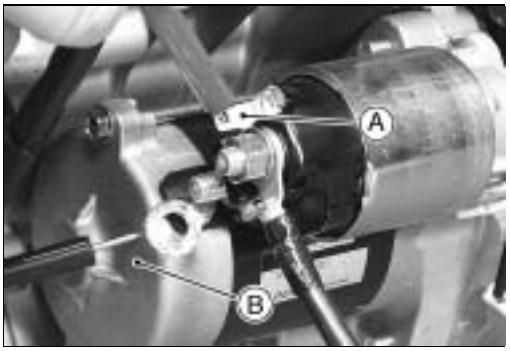
Electric Starter System

- Set the hand tester to the R x 1 Ω position and connect the leads as shown.

★If the tester does not read close to 0 Ω, the solenoid is faulty. Replace it.

★If the tester reads close to 0 Ω, the solenoid may be good. Check the voltage to the solenoid from the engine switch.

A. Switch Terminal
B. To Ground

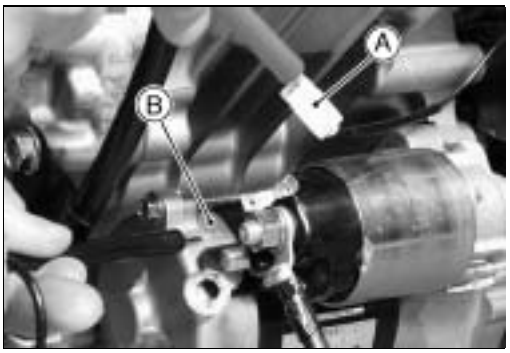


- Set the hand tester selector switch to the 25 VDC position and connect it as shown.
- Turn the engine switch to the START (II) position and read the tester.

★If the tester reads battery voltage, the circuit is good. If the solenoid would not click in the previous test, it is faulty. Replace it.

★If the tester reads much less than battery voltage or no voltage at all, either the wiring or the engine switch is bad. Check the engine switch or the wiring for damaged or broken wires and replace as required.

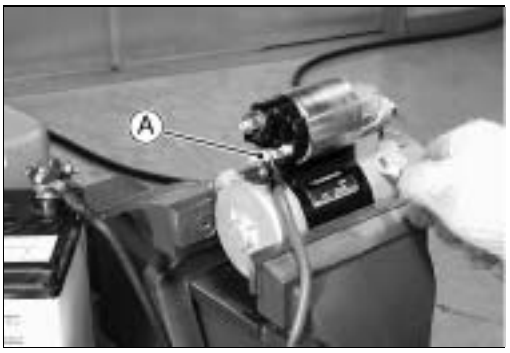
[A] Switch Lead Connector
[B] To Ground



Starter Motor Test

CAUTION

Be careful not to deform the starter motor body when holding it with a vice.



- Remove the starter motor.
- Hold the starter motor with a vice as shown.
- Connect the first jumper cable to the battery (+) terminal and the other end of the cable to the starter motor terminal [A] on the solenoid.
- Connect the second jumper cable to the battery (–) terminal.
- Touch the starter body with the other end of the second jumper cable intermittently for one second intervals.
- The pinion should rotate freely.

★If the pinion does not rotate freely, replace the starter motor.

No-Load Starter Draw Bench Test

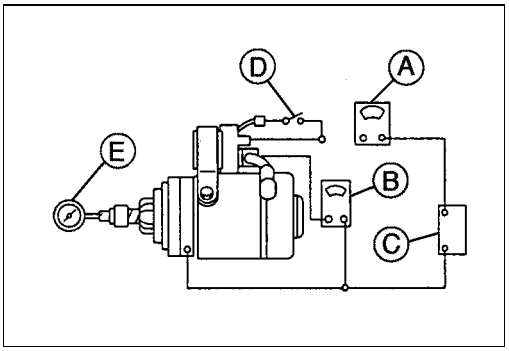
Needed for the test are:
A tachometer capable of reading 15 000 r/min (rpm)
12 V, 32 AH battery or more
An ammeter capable of reading 100 A

⚠ WARNING

Battery electrolyte is poisonous and corrosive. It is injurious to eyes, skin and clothing. Handle it carefully.
If electrolyte is spilled, flush immediately with a solution of one part baking soda to four parts water.

Electric Starter System

● Connect the starter motor, battery and ammeter as shown.
[A] Ammeter
[B] Voltmeter
[C] Battery
[D] Switch
[E] Tachometer



NOTE

○ *Starter motor should not be loaded. The test should be quickly conducted, as the rating is 30 seconds.*

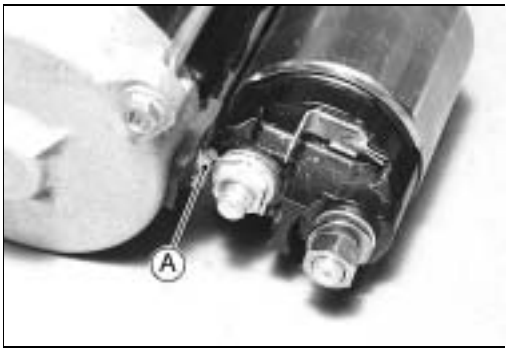
● Active the starter motor. The starter motor in good condition will be within following specifications.

Terminal Voltage	11.5 V
Starter Motor RPM	6 000 (MIN)
Current Draw (A)	50 (MAX)

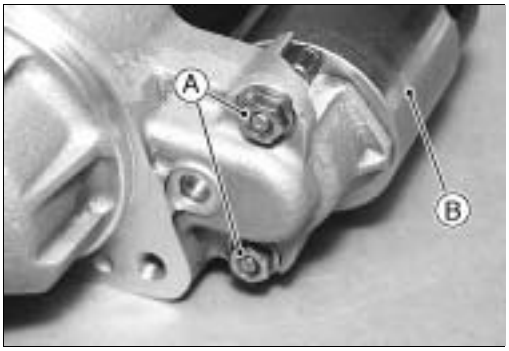
★If not, check for the following and correct if necessary.
○ A binding or seizing condition in the starter motor bearings.
○ Starter motor brushes sticking in the brush holders.
○ A dirty or worn armature commutator or brushes.
○ A shorted, open, or grounded armature or field coil.
○ A defective starter motor switch.

Starter Motor Disassembly

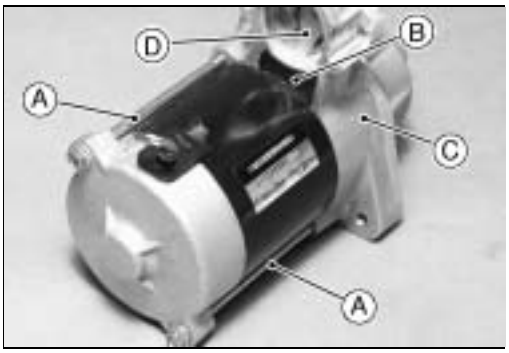
● Pull back the rubber boot and remove the lead [A] from the starter motor to the solenoid.



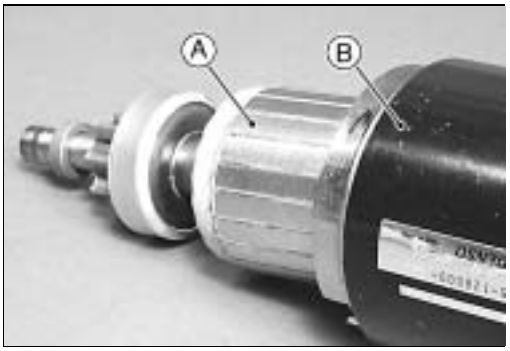
● Unscrew the mounting nuts [A] and remove the solenoid assembly [B].



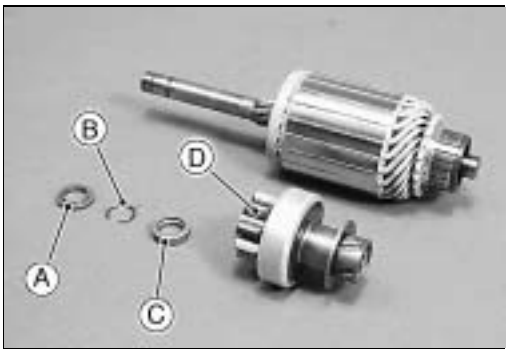
● Pull the rubber insert [B] from the starter motor and remove the pinion gear cover [C] as shown.
● Slip the actuating arm [D] from the pinion gear.
[A] Through Bolts



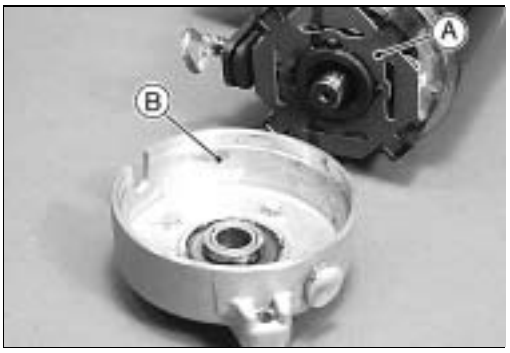
- Pull the armature [A] from the yoke [B].



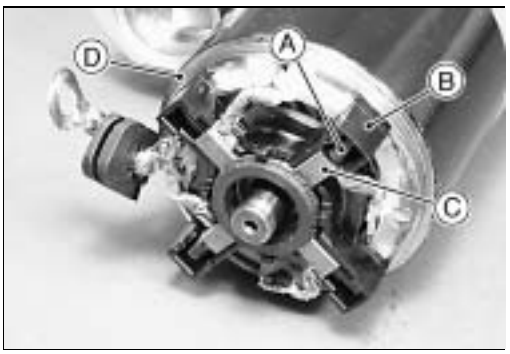
- Separate the front and rear stoppers each other using a screw driver and remove the front stopper.
- Push the rear stopper down the shaft and remove the snap ring.
- Pull the rear stopper and pinion gear from the armature shaft.
  [A] Front Stopper
  [B] Snap Ring
  [C] Rear Stopper
  [D] Pinion Gear



- Gently pull the end cover [B] from the yoke and remove the insulator [A].



- Using a needle nose pliers, remove the brush springs from the brush holder.
- Separate the brushes from the holder and remove the holder from the yoke.
  [A] Brush Spring
  [B] Brush Holder
  [C] Brush
  [D] Yoke



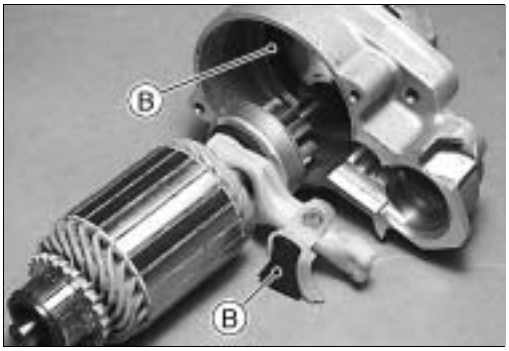
Starter Motor Assembly Notes

- Apply a small amount of grease to the armature shaft [A] as shown.
- Do not reuse the snap ring [B]. Replace it with a new one.

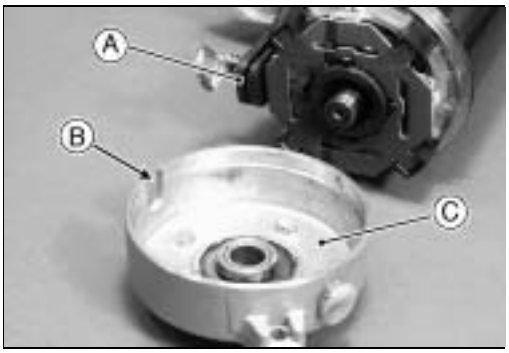
Electric Starter System

- Inspect the rubber insert [B] and/or boot [A] for visible damage.

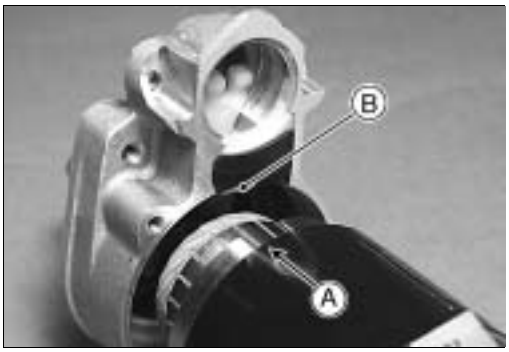
★If they are damaged, replace them.



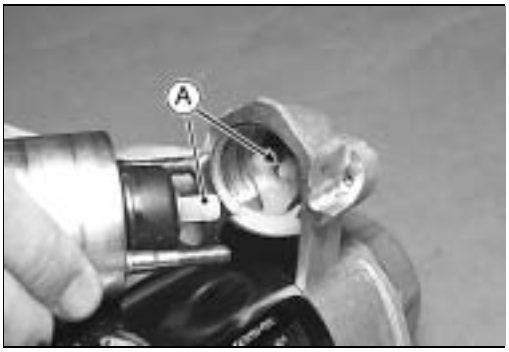
- Fit the notch [A] in the (-) lead grommet onto the projection [B] on the end cover [C].



- Grease the pinion gear fork fingers.
- Set the pinion gear fork so that the fingers fit into the groove in the gear.
- Fit the notch [A] in the yoke onto the projection [B] on the pinion gear fork.

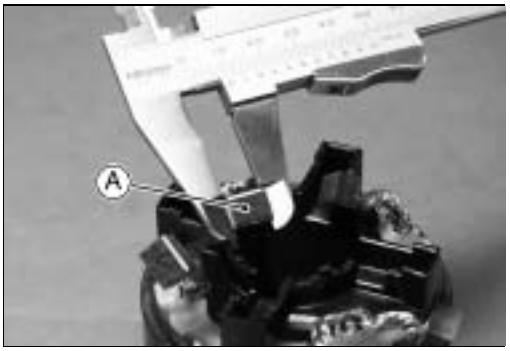


- Engage the hook [A] on the starter solenoid with the hook [A] on the pinion gear fork.



Electric Starter System

Starter Motor Brush Inspection



- Measure the overall length of each brush [A].

★If the brushes are shorter than the service limit, replace them.

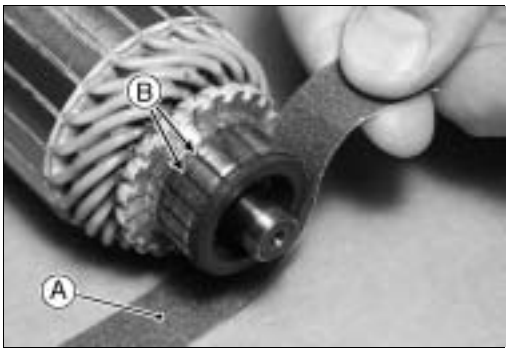
Brush Length
Service Limit: 6.0 mm (0.24 in.)

Brush Spring Inspection

- Inspection the brush springs for pitting, cracks, rusting and burrs. Replace the spring if necessary.
- Inspect the springs for weakened conditions and distortion. Replace the springs if necessary.

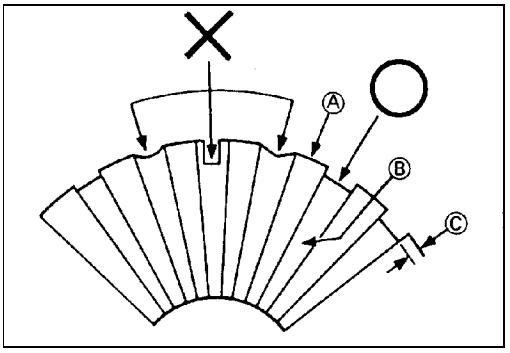
★If the brush springs are able to press the brushes firmly into place, they may be considered serviceable. If they cannot, replace them.

Armature Inspection



- Inspect the surface of the commutator.

★If it is scratched or dirty, polish it with a piece of very fine emery cloth [A], and clean out the grooves [B].



- Measure the depth of the grooves between the commutator segments.

★If the grooves are shallower than the specified limit, undercut the insulating material to the standard depth 0.5 to 0.8 mm (0.012 to 0.031 in) using a thin file.

★If the grooves are only dirty, clean them carefully.

Commutator Groove Depth Limit
Less than 0.2 mm (0.008 in.)

[A] Segment
[B] Mica
[C] Depth

- Measure the commutator outside diameter at several points.

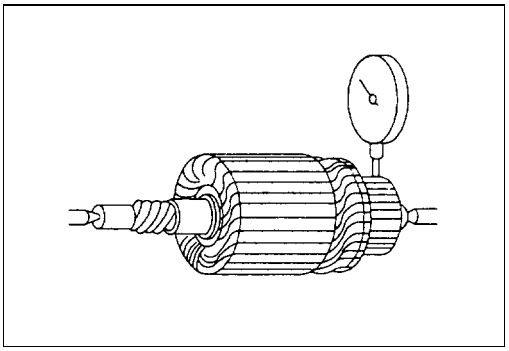
★If the diameter is less than the service limit, replace the armature with a new one.

Commutator Outside Diameter
Service Limit: 27 mm (1.06 in.)

Electric Starter System

- Support the armature in an alignment jig at each end of the shaft as shown. Position a dial indicator perpendicular to the commutator.
- Rotate the armature slowly and read the commutator runout.
- ⋆ If runout is more than the service limit, replace the armature with a new one.

Commutator Runout
Service Limit: 0.4 mm (0.016 in.)

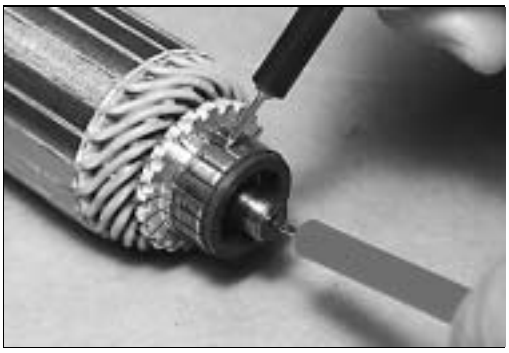


- Measure the armature winding resistance.
- ○ Set the multimeter selector switch to the R × 1 Ω position and check the resistance between each segment and all the others.
- ★ If the resistance it too high or even infinite, the armature winding has an open circuit. Replace the starter motor.

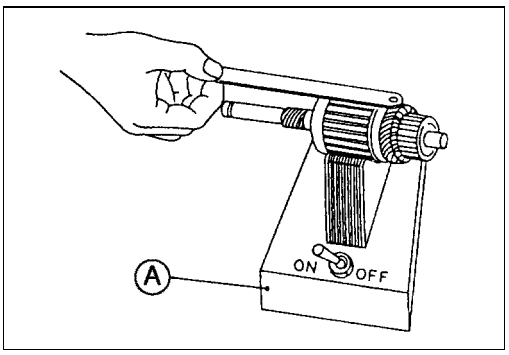
Armature Winding Resistance
Close to 0 Ω

- Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the commutator and the armature shaft.
- ★ If the resistance is less than infinite, the armature is shorted.

Commutator to Shaft Resistance
(∞)



- Test the armature winding for shorts.
- ○ Place the armature on a growler [A].
- ○ Hold a thin metal strip (e.g., hack saw blade) on top of the armature.
- ○ Turn on the growler and rotate the armature one complete turn.
- ★ If the metal strip vibrates, the windings are internally shorted to each other and the starter motor must be replaced.



Yoke Assembly Inspection

- Set the multimeter selector switch to the R × 1 kΩ position and measure the resistance between the positive brush(es) and stator motor yoke.
- ★ If the resistance is less than infinite, the positive brush is shorted to ground. Replace the yoke assembly.

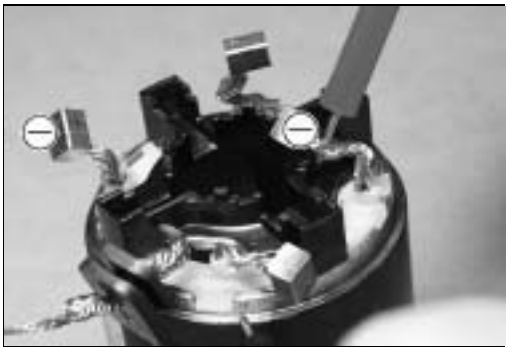
Positive Brush to Ground Resistance
(∞)

Electric Starter System

- Set the multimeter selector switch to the R × 1 Ω position and measure the resistance between the negative brush(es) and starter motor yoke.

★If the meter dose not read close to 0 Ω, the yoke assembly is faulty. Replace it.

Negative Brush to Ground Resistance
Close to 0 Ω



Pinion Clutch Inspection

- Remove the pinion clutch.
- Turn the pinion gear by hand. The pinion gear should turn counter-clockwise freely, but should not turn clockwise (→).

★If the pinion clutch dose not operate as it should, or if it makes noise, replace the pinion clutch.

Troubleshooting

Table of Contents

Engine Troubleshooting Guide....8-2
FD791D (DFI Model) Trouble shooting....8-7
Starter Motor Troubleshooting Guide....8-8

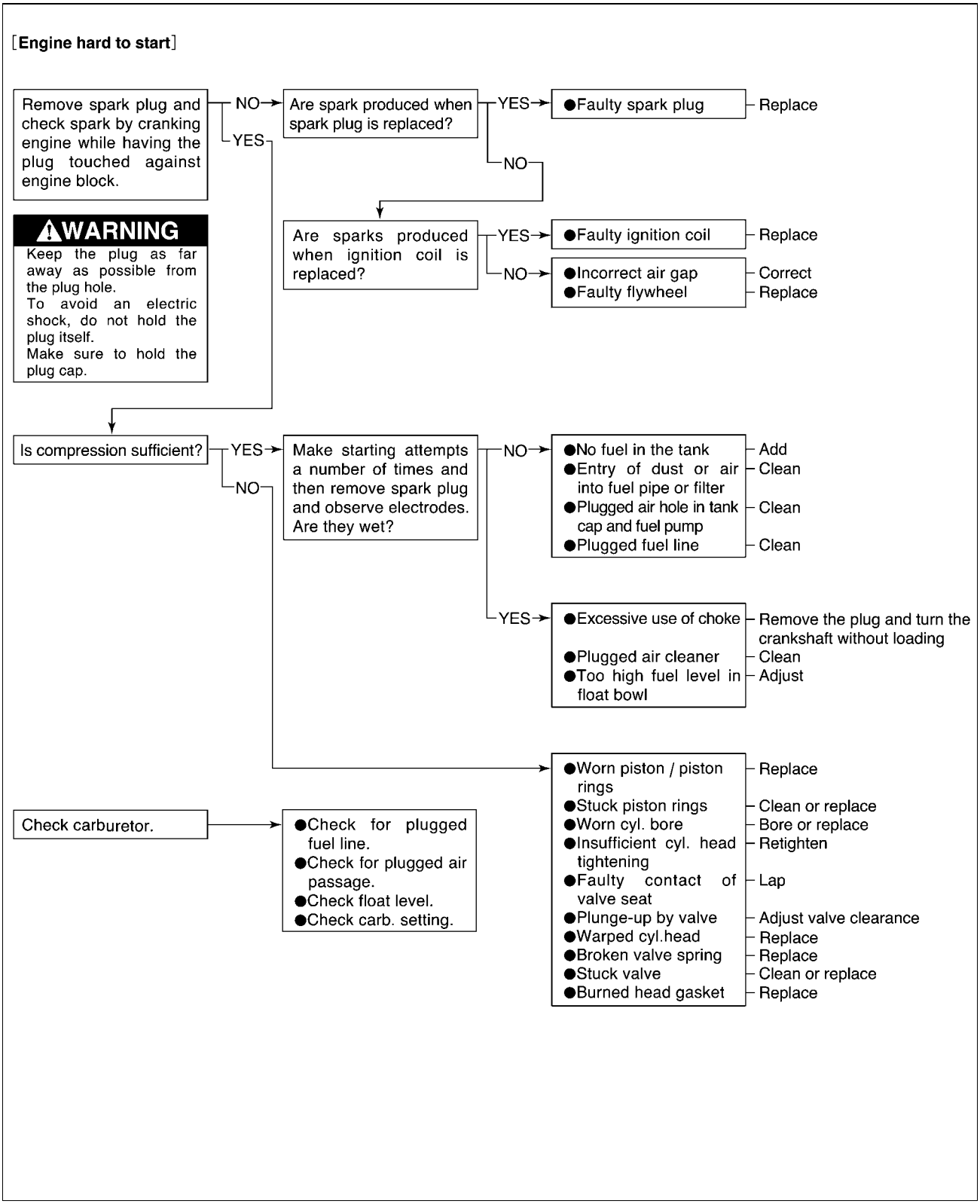
8-2 TROUBLESHOOTING

Engine Troubleshooting Guide

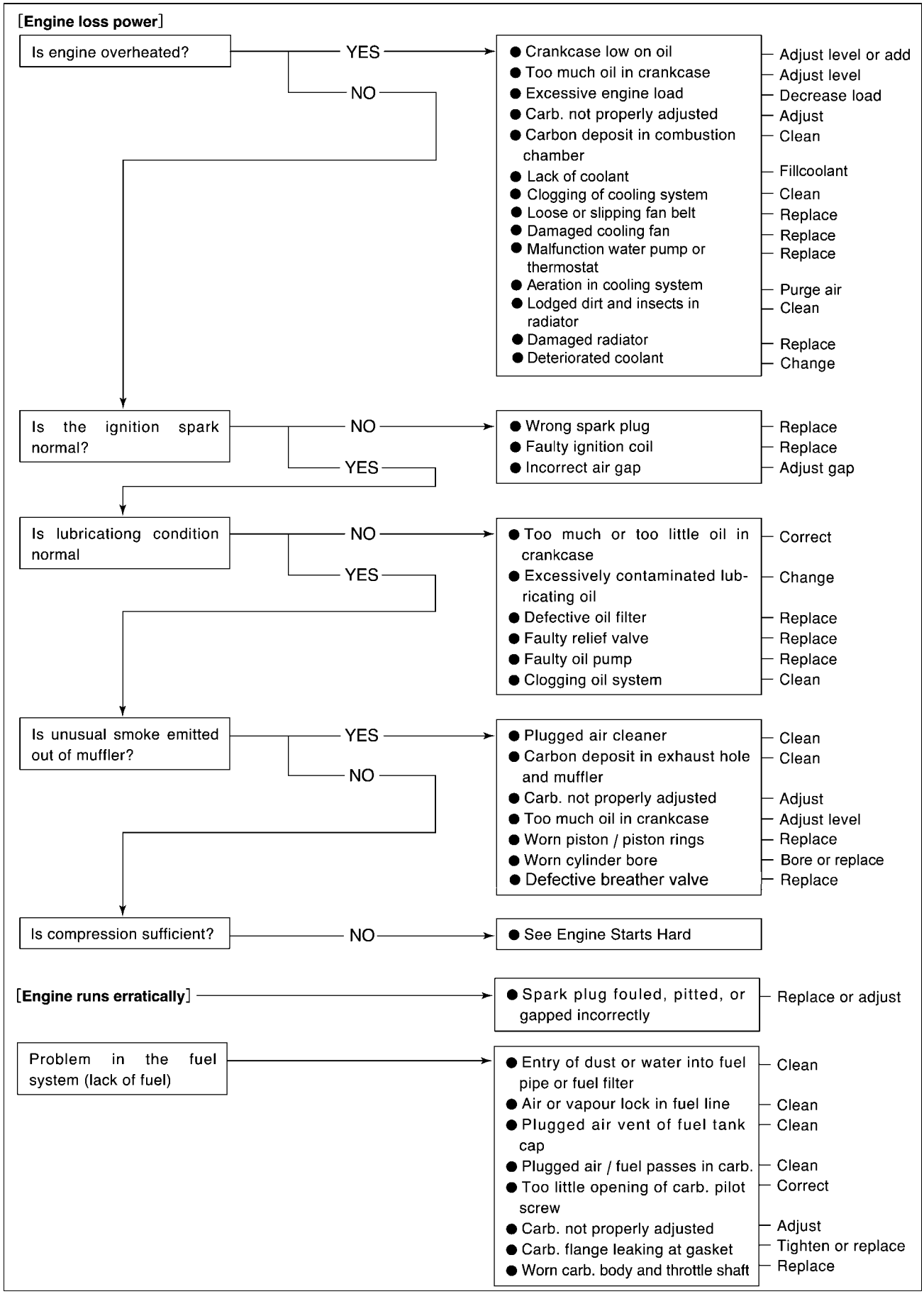
If the engine malfunctions, check if the way the engine is used is correct. If engine malfunctions even if engine is used correctly, systematically carry out troubleshooting starting with simple points.

This chart describes typical troubleshooting procedures.

Do not unnecessarily disassemble carburetor, magneto or engine unless it has been found to be the cause of malfunctioning.



Engine Troubleshooting Guide


[Engine loss power]
Is engine overheated?
YES
NO
● Crankcase low on oil — Adjust level or add
● Too much oil in crankcase — Adjust level
● Excessive engine load — Decrease load
● Carb. not properly adjusted — Adjust
● Carbon deposit in combustion chamber — Clean
● Lack of coolant — Fillcoolant
● Clogging of cooling system — Clean
● Loose or slipping fan belt — Replace
● Damaged cooling fan — Replace
● Malfunction water pump or thermostat — Replace
● Aeration in cooling system — Purge air
● Lodged dirt and insects in radiator — Clean
● Damaged radiator — Replace
● Deteriorated coolant — Change
Is the ignition spark normal?
NO
YES
● Wrong spark plug — Replace
● Faulty ignition coil — Replace
● Incorrect air gap — Adjust gap
Is lubricationg condition normal
NO
YES
● Too much or too little oil in crankcase — Correct
● Excessively contaminated lubricating oil — Change
● Defective oil filter — Replace
● Faulty relief valve — Replace
● Faulty oil pump — Replace
● Clogging oil system — Clean
Is unusual smoke emitted out of muffler?
YES
NO
● Plugged air cleaner — Clean
● Carbon deposit in exhaust hole and muffler — Clean
● Carb. not properly adjusted — Adjust
● Too much oil in crankcase — Adjust level
● Worn piston / piston rings — Replace
● Worn cylinder bore — Bore or replace
● Defective breather valve — Replace
Is compression sufficient?
NO
● See Engine Starts Hard
[Engine runs erratically]
● Spark plug fouled, pitted, or gapped incorrectly — Replace or adjust
Problem in the fuel system (lack of fuel)
● Entry of dust or water into fuel pipe or fuel filter — Clean
● Air or vapour lock in fuel line — Clean
● Plugged air vent of fuel tank cap — Clean
● Plugged air / fuel passes in carb. — Clean
● Too little opening of carb. pilot screw — Correct
● Carb. not properly adjusted — Adjust
● Carb. flange leaking at gasket — Tighten or replace
● Worn carb. body and throttle shaft — Replace

Engine Troubleshooting Guide

Problem in the governor system →
- ●Incorrect governor linkage adjustment — Correct
- ●Faulty governor spring — Replace
- ●Governor ass'y malfunctioning — Check

[**Engine malfunctions at high speed**]

Is revolution fluctuation of relatively large period produced when a load is applied? — YES →
- ●Plugged air hole in tank cap — Clean
- ●Entry of dust and air into fuel filter or fuel pipe. — Clean

[**Engine malfunctions at low speed**]

Remove spark plug and check spark by cranking engine while having the plug touched against engine block.
- WEAK →
  - ●Faulty plug insulation — Replace
  - ●Fouled electrodes — Clean
  - ●Faulty ignition coil — Replace
  - ●Incorrect air gap — Correct
- STRONG

⚠WARNING

Keep the plug as far away as possible from the plug hole.
To avoid an electric shock, do not hold the plug itself. Make sure to hold the plug cap.

Is unusual smoke emitted out of muffler?
- YES → ●Overrich fuel in pilot system — Turn in pilot screw by a minor extent
- NO

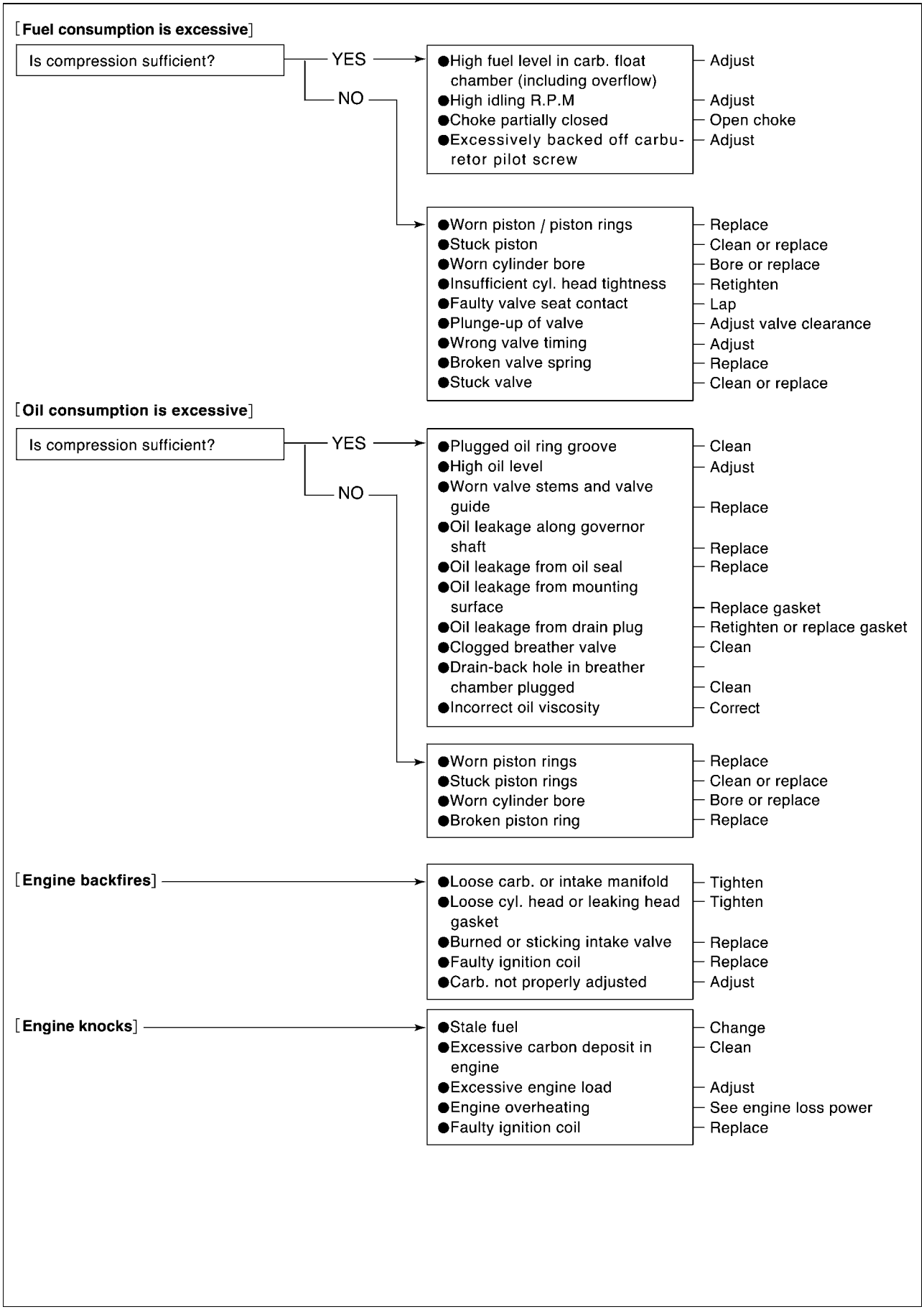
Directly and gradually open throttle valve by hand. Does the revolution drop or does engine stall at a certain position?
- YES → ●Plugged in carburetor interior — Disassemble and clean
- NO

Is air sucked through carburetor or intake manifold flanges.
- YES → ●Loose flange nuts — Retighten; ●Damaged gasket — Replace
- NO

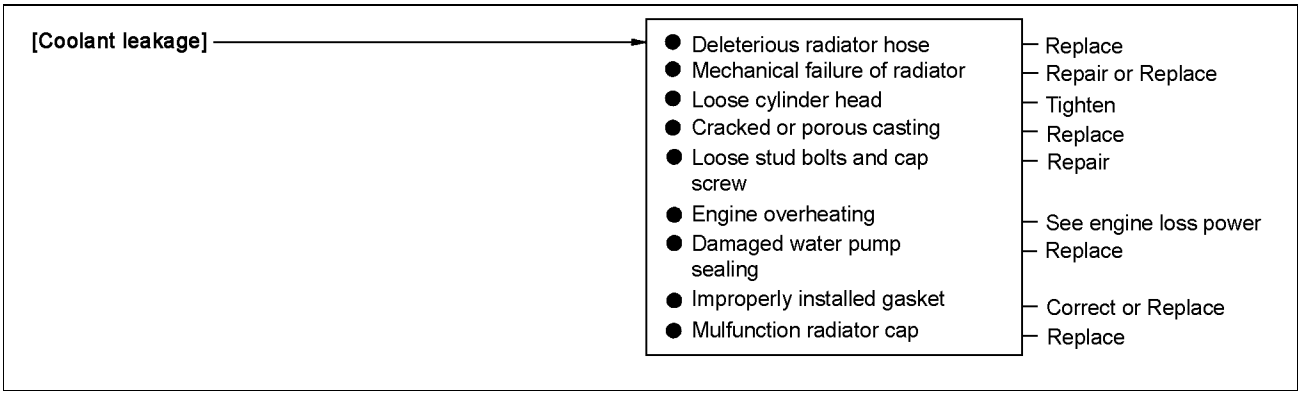
Are valve clearances of normal values?
- NO → ●Compression leakage — Adjust valve clearance; ●Wrong valve timing — Correct alignment of timing gear marks
- YES

Is alignment of timing gear marks correct?
- NO → ●Largely deviated valve timing — Correct alignment of timing gear marks

Engine Troubleshooting Guide


[Fuel consumption is excessive]
Is compression sufficient?
YES
NO
●High fuel level in carb. float chamber (including overflow) — Adjust
●High idling R.P.M — Adjust
●Choke partially closed — Open choke
●Excessively backed off carburetor pilot screw — Adjust
●Worn piston / piston rings — Replace
●Stuck piston — Clean or replace
●Worn cylinder bore — Bore or replace
●Insufficient cyl. head tightness — Retighten
●Faulty valve seat contact — Lap
●Plunge-up of valve — Adjust valve clearance
●Wrong valve timing — Adjust
●Broken valve spring — Replace
●Stuck valve — Clean or replace
[Oil consumption is excessive]
Is compression sufficient?
YES
NO
●Plugged oil ring groove — Clean
●High oil level — Adjust
●Worn valve stems and valve guide — Replace
●Oil leakage along governor shaft — Replace
●Oil leakage from oil seal — Replace
●Oil leakage from mounting surface — Replace gasket
●Oil leakage from drain plug — Retighten or replace gasket
●Clogged breather valve — Clean
●Drain-back hole in breather chamber plugged — Clean
●Incorrect oil viscosity — Correct
●Worn piston rings — Replace
●Stuck piston rings — Clean or replace
●Worn cylinder bore — Bore or replace
●Broken piston ring — Replace
[Engine backfires]
●Loose carb. or intake manifold — Tighten
●Loose cyl. head or leaking head gasket — Tighten
●Burned or sticking intake valve — Replace
●Faulty ignition coil — Replace
●Carb. not properly adjusted — Adjust
[Engine knocks]
●Stale fuel — Change
●Excessive carbon deposit in engine — Clean
●Excessive engine load — Adjust
●Engine overheating — See engine loss power
●Faulty ignition coil — Replace

Engine Troubleshooting Guide



Engine Troubleshooting Guide

FD791D (DFI Model) Trouble shooting

Trouble shooting guide shows the relationship between systams and inspection items which could be causing the trouble.

Operations \ Symptoms		Engine will not start	Engine starts but falls to keep running	Engine runs but misses	Engine misses when advancing throttle	Engine will not idle	Engine runs erratically	Engine loses power	Engine does not maintain constant speed(surges)	Engine overheats	Engine knocks	Engine back fires	Engine after fires	Exhaust smokes excessively	Excessive fuel consmption	
Fuel pump Inspection		●	●			●		○								
Fuel pump relay inspection		●	○													
Fuel injection	Aural inspection	●	○			●	○	○					○		○	
	Injector signal inspection	○				○			○	○	○	○	○			
Engine speed sensor inspection		●	●													
Fuel pressure inspection		●	●	●	○	●	○	●	●	●	●	●	○	●	●	
Pressure regulator inspection		○	○	○	○	○		○	○	○	○	○		○	○	
Fuel leak inspection		○	○			○	○	●		●	●		○		●	
Fuel system cleaning		○	○			○	●	●	○	○		○	○	●	●	
Fuel fillter inspection		○	○			○	○	●	○			○	○	○	●	
Air Temperature sensor inspection		○		○	○			○	○	○	○	●	●	●	●	
Water temperature sensor inspection		○		●	○	○	○	○	○	○	○	●	●	●	●	
Pressure sensor inspection		○	○	●	●	●	○	○	●	○	●	○	○	○	●	
Throttle valve inspection			●			●	●		●							
Idle speed setting inspection						●										
Harness inspection		●	●	○	○		●	●	○	●	●	●	●	●	○	
Air leak inspection		○	○			●	●	○	●	●	●	○	○		○	
Replace control unit		●	○	○	○	○	○	●	○	○	○	●	○	●	●	

NOTE

○ *For troubles in fuel injection system only. Prerequisite is that the ignition system and the engine be in satisfactory condition.*

● : Main inspection items

○ : Subordinate inspection items

Starter Motor Troubleshooting Guide

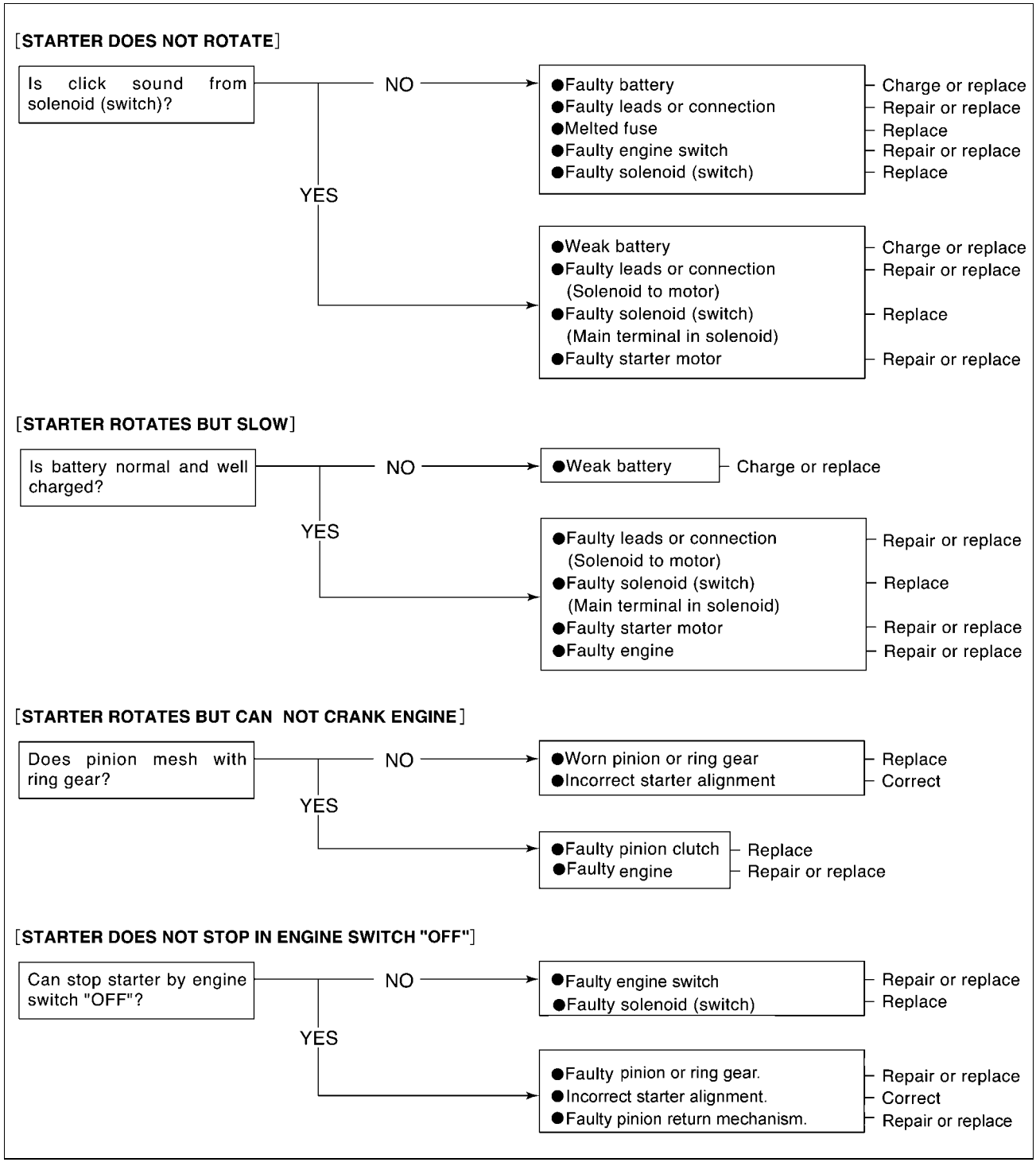
1. Disconnect spark plug cap, and ground the cap terminal.
2. Turn engine switch to “START” position and check condition.

⚠ WARNING

Engine may be cranked in this test. Do not touch any rotating parts of engine and equipment during test.

CAUTION

If starter does not stop by engine switch “OFF”, disconnect negative (–) lead from battery as soon as possible.


[STARTER DOES NOT ROTATE]
Is click sound from solenoid (switch)?
NO
YES
●Faulty battery — Charge or replace
●Faulty leads or connection — Repair or replace
●Melted fuse — Replace
●Faulty engine switch — Repair or replace
●Faulty solenoid (switch) — Replace
●Weak battery — Charge or replace
●Faulty leads or connection (Solenoid to motor) — Repair or replace
●Faulty solenoid (switch) (Main terminal in solenoid) — Replace
●Faulty starter motor — Repair or replace
[STARTER ROTATES BUT SLOW]
Is battery normal and well charged?
NO
YES
●Weak battery — Charge or replace
●Faulty leads or connection (Solenoid to motor) — Repair or replace
●Faulty solenoid (switch) (Main terminal in solenoid) — Replace
●Faulty starter motor — Repair or replace
●Faulty engine — Repair or replace
[STARTER ROTATES BUT CAN NOT CRANK ENGINE]
Does pinion mesh with ring gear?
NO
YES
●Worn pinion or ring gear — Replace
●Incorrect starter alignment — Correct
●Faulty pinion clutch — Replace
●Faulty engine — Repair or replace
[STARTER DOES NOT STOP IN ENGINE SWITCH "OFF"]
Can stop starter by engine switch "OFF"?
NO
YES
●Faulty engine switch — Repair or replace
●Faulty solenoid (switch) — Replace
●Faulty pinion or ring gear. — Repair or replace
●Incorrect starter alignment. — Correct
●Faulty pinion return mechanism. — Repair or replace